TWENTY-SIXTH ANNUAL REPORT

OF THE

Maine Agricultural Experiment Station

ORONO, MAINE.

1910

STATE OF MAINE.
1911.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

Organization January to June, 1910.

THE STATION COUNCIL.

THE STATION STAFF.

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	BLANCHE F. POOLER,	*Stenographer*
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PLANT PATHOLOGY	WARNER, J. MORSE, M. S.,	*Pathologist*
	CHARLES E. LEWIS, Ph. D.,	*Associate*
	JOHN SUMMERS,	*Laboratory Assistant*
HIGHMOOR FARM,	WELLINGTON SINCLAIR,	*Superintendent*
ROYDEN L. HAMMOND,		*Seed Analyst and Photographer*
HENRY A. MILLET,		*Meteorological Observer and Janitor*

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The publications of this Station will be sent free to any address in Maine. All requests should be sent to

Agricultural Experiment Station,
Orono, Maine.

CONTENTS.

ANNOUNCEMENTS.

Establishment of the Station.

The Maine Fertilizer Control and Agricultural Experiment Station, established by Act of the Legislature approved March 3, 1885, began its work in April of that year in quarters furnished by the College. After the Station had existed for two years, Congress passed what is known as the Hatch Act, establishing agricultural experiment stations in every state. This grant was accepted by the Maine Legislature by an Act approved March 16, 1887, which established the Maine Agricultural Experiment Station as a department of the University. The reorganization was effected in June, 1887, but work was not begun until February 16, 1888. In 1906 Congress passed the Adams Act for the further endowment of the stations established under the Hatch Act.

The purpose of the experiment stations is defined in the Act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

The work that the Experiment Station can undertake from the Adams Act fund is more restricted and can "be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective states and territories."

Any resident of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province.

Investigations.

The Station continues to restrict its work to a few important lines, believing that it is better for the agriculture of the State to study thoroughly a few problems than to spread over the whole field of agricultural science. It has continued to improve its facilities and segregate its work in such a way as to make it an effective agency for research in agriculture. Prominent among the lines of investigation are studies upon the food of man and animals, the diseases of plants and animals, breeding of plants and animals, orchard and field experiments, poultry investigations, and entomological research.

Inspections.

The inspection of food and drugs, the inspection of fertilizers, the inspection of concentrated commercial feeding stuffs, the inspection of agricultural seeds, and the testing of the graduated glassware used in creameries, are entrusted to the Station through its director, who is responsible for the execution of the public laws relating to these matters. The cost of the inspections is borne by a state appropriation, and the examination of chemical glassware by a charge for calibration.

Offices and Laboratories.

The offices, laboratories and poultry plant of the Maine Agricultural Experiment Station are at the University of Maine, Orono. Orono is the freight, express, post, telegraph and telephone address for the offices and laboratories.

Visitors to the Station will find it convenient to leave the steam cars at Bangor or Old Town, as the railway station at

Orono is a mile from the University. Bangor and Old Town trolley cars pass through the campus. They pass the railway station in Bangor 5 minutes after the hour and half hour, and the railway station in Old Town, 20 minutes after and 10 minutes before the hour.

Highmoor Farm.

Highmoor Farm, purchased by the State for the use of the Station, is located in the town of Monmouth, 2½ miles from the Monmouth station and the same distance from the Leeds Junction station. It is on the Farmington branch of the Maine Central Railroad. A flag station, called Highmoor, is on the farm. Monmouth is the post, telegraph and telephone address for Highmoor Farm. Both Leeds Junction and Monmouth are freight and express addresses.

Visitors are always welcome. Granges, Farmers' Clubs and others desiring to visit Highmoor Farm are requested to arrange dates in advance.

The Aim of the Station.

Every citizen of Maine concerned in agriculture has the right to apply to the Station for any assistance that comes within its province. It is the wish of the Trustees and Station Council that the Station be as widely useful as its resources will permit.

In addition to its work of investigation, the Station is prepared to make chemical analyses of fertilizers, feeding stuffs, dairy products and other agricultural materials; to test seeds and creamery glassware; to identify grasses, weeds, injurious fungi and insects, etc.; and to give information on agricultural matters of interest and advantage to the citizens of the State.

All work proper to the Experiment Station and of public benefit will be done without charge. Work for the private use of individuals is charged for at the actual cost to the Station. The Station offers to do this work only as a matter of accommodation. Under no condition will the Station undertake analyses, the results of which cannot be published, if they prove of general interest.

CORRESPONDENCE.

As far as practicable, letters are answered the day they are received. Letters sent to individual officers are liable to remain unanswered, in case the officer addressed is absent. All communications, should, therefore, be addressed to the Director or to the

Agricultural Experiment Station,
Orono, Maine.

PUBLICATIONS.

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station. These make up the annual report for the year. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and are bound in with the annual report as an appendix thereto. Miscellaneous publications consisting of newspaper notices of bulletins, newspaper bulletins and circulars which are not paged consecutively and for the most part are not included in the annual report are issued during the year.

All of the bulletins issued by the Station are sent to the names upon the official mailing list prepared by the Office of Experiment Stations, to all newspapers in Maine and to libraries and to agricultural exchanges. Bulletins which have to do with general agriculture and the Official Inspections which bear upon the feeding stuffs, fertilizer and seed inspections are sent to a general mailing list composed chiefly of farmers within the State. The publications having to do with the food and drug inspection are sent to a special list including all dealers in Maine and other citizens who request them. The annual report is sent to directors of experiment stations and to libraries. Copies of all publications are sent to the newspapers within the State and to the press on the exchange list outside of the State.

BULLETINS PUBLISHED IN 1910.

Bulletin 176. The Ligaments of the Oviduct of the Domestic Fowl. 20 pages, 9 illustrations.
Bulletin 177. Insect Notes for 1909. 24 pages, 37 illustrations.
Bulletin 178. An Endomyces from Apple. 20 pages, 14 illustrations.
Bulletin 179. Poultry Notes. 60 pages, 10 illustrations.
Bulletin 180. Fungus Gnats of North American. Part II. 68 pages, 65 illustrations.
Bulletin 181. Galls Aphids of the Elm. 48 pages, 72 illustrations.
Bulletin 182. Four Rare Aphid Genera from Maine. 8 pages, 22 illustrations.
Bulletin 183. Experiments in Breeding Sweet Corn. 68 pages, 15 illustrations.
Bulletin 184. Digestion Experiments with Poultry. 20 pages, 2 illustrations.
Bulletin. 185. Maine Apple Diseases. 56 pages, 30 illustrations.
Bulletin 186. Meteorology Finances. Index pages

OFFICIAL INSPECTIONS ISSUED IN 1910.

No. 19. Fertilizer Inspection. 28 pages.
No. 20. Feeding Stuff Inspection. 8 pages.
No. 21. Miscellaneous Food Materials. 8 pages.
No. 22. Miscellaneous Food Materials. 12 pages.
No. 23. Feeding Stuff Inspection. 16 pages.
No. 24. Miscellaneous Food Materials. 12 pages.
No. 25. Food and Drug Regulations. 4 pages.
No. 26. Headache Remedies. 8 pages.
No. 27. Soda Water and Ice Cream. 30 pages.
No. 28. Seed Inspection. 16 pages.

MISCELLANEOUS PUBLICATIONS ISSUED IN 1910.

No. 371. Blackleg, a Bacterial Disease of potatoes. 1 page.
No. 372. Notice to Accompany Bulletin. 1 page.
No. 373. List of Publications, 1909. 1 page.
No. 374. Letter to Shippers of Maine Seed Potatoes. 4 pages.
No. 375. Certain Diseases of Maine Potatoes and Their Relation to the Seed Trade. 12 pages.
No. 376. Seed Potatoes and Late Blight. 1 page.
No. 377. Home-mixed Fertilizers. 20 pages.
No. 378. Oyster-shell Bark Louse. 4 pages.
No. 379. Organic Ammoniates and Mixed Fertilizers. 1 page.
No. 380. Insect Notes for 1909. 1 page.
No. 381. Invitation Anniversary Exercises. 1 page.
No. 382. List Entomological Papers. 16 pages.
No. 383. Apple Tree Insects of Maine. 68 pages.
No. 384. Organization of Station. 1 page.

No. 385. Exercises at the Twenty-fifth Anniversary of the Establishment of the Station. 38 pages.
No. 386. Plant Diseases. 4 pages.
No. 387. Maine Seed Potatoes. 1 page.
No. 388. Experiments at Highmoor Farm, 1910. 4 pages.
No. 389. Apple Tree Insects. 1 page.
No. 390. Poultry Notes. 1 page.
No. 391. List of Bulletins, 1903-1908. 2 pages.
No. 392. Sweet Corn Culture and Breeding. 1 page.
No. 393. Practical Suggestions Regarding the Growing of Sweet Corn. 8 pages.
No. 394. Poultry Notes. Reprint popular part Bulletin 179. 20 pages.
No. 395. Poultry Plant Notice. 1 page.
No. 396. Digestion Experiments with Poultry. 8 pages.
No. 397. Seed Potatoes, Oats and Corn. 4 pages.

BIOLOGY PUBLICATIONS—1910.

In the numbered series of "Papers from the Biological Laboratory."

No. 16. The Ligaments of the Oviduct of the Domestic Fowl. By Maynie R. Curtis. Maine Expt. Sta. Bul. 176, pp. 1-20, 3 plates.

No. 17. On the Inheritance of the Barred Color Pattern in Poultry. By R. Pearl and F. M. Surface. Archiv. f. Entwicklungsmechanik. Bd. XXX (Festband für Roux) I Teil, pp. 45-61. 2 plates.

No 18. Experiments in Breeding Sweet Corn. By R. Pearl and F. M. Surface. Maine Agric. Expt. Sta. Annual Rept. for 1910.

✓ No. 19. Inheritance in "Blood Lines" in Breeding Animals for Performance, with Special Reference to the "200-egg" Hen. By R. Pearl. Ann. Rept. Amer. Breeders Assoc. Vol. VI. (In press).

No. 20. A Biometrical Study of Egg Production in the Domestic Fowl. II. The Seasonal Distribution of Egg Production. By R. Pearl and F. M. Surface. U. S. Dept. Agr. Bur. Anim. Ind. Bulletin 110, Part II.

No. 21. Studies on Hybrid Poultry. By R. Pearl and F. M. Surface. Me. Agr. Expt. Sta. Annual Rept. for 1910, pp. 84-115.

✓ No. 22. Further Data Regarding the Sex Limited Inheritance of the Barred Color Pattern in Poultry. By R. Pearl and F. M. Surface. Science, N. S. Vol. XXXII, pp. 870-874.

✓ No. 23. Data on the Relative Inconspicuousness of Barred and Self-colored Fowls. By R. Pearl, American Naturalist, Vol. XLV, pp. 107-117.

Papers published, but not in the numbered series:

a. Poultry Notes—1910. By R. Pearl and F. M. Surface. Me. Agr. Expt. Sta. Bulletin 179, pp. 65-134.

b. The Relation of the Results Obtained in Breeding Poultry for Increased Egg Production to the Problem of Selection. By R. Pearl. Rept. 30th Meeting Soc. Prom. Agr. Sci. pp. (of reprint) 1-8.

c. Intra-individual Variation and Heredity. By R. Pearl. Proc. Seventh Internat. Zool. Congress. pp. (of reprint) 1-3.

d. The Possible Eugenic Bearing of Certain Experiments with Poultry. By R. Pearl. Eugenic Review, April 1910, Vol. II.

e. Breeding for Production in Dairy Cattle in the Light of Recent Advances in the Study of Inheritance. By R. Pearl. Eighth Ann. Rept. Comm. Agr. Maine, pp. 118-129, 1910.

f. Inheritance of Hatching Quality of Eggs in Poultry. By R. Pearl. Amer. Breeders Mag. Vol. I, pp. 129-133.

ENTOMOLOGY PUBLICATIONS.

No. 41. Bul. 177. Insect Notes for 1909. O. A. J. pp. 21-44.
No. 42. Bul. 180. Fungus Gnats, II, O. A. J. pp. 125-192.
No. 43. Bul. 181. Gall Aphids of the Elm. E. M. P. pp. 193-240.
No. 44. Bul. 182. Four Rare Aphid Genera From Maine. E. M. P. pp. 241-248.

CHANGES IN STATION STAFF.

April 1 Joseph F. Merrill resigned as Assistant Chemist to accept a similar position at the Massachusetts Agricultural Experiment Station.

April 1 Harry M. Woods resigned as Assistant to the Director.

July 1 Alfred K. Burke and Raymond P. Norton were appointed Assistant Chemists.

December 1 Mr. Norton resigned to accept a position with the Bureau of Animal Industry, of the United States Department of Agriculture.

BULLETIN No. 176.

THE LIGAMENTS OF THE OVIDUCT OF THE DOMESTIC FOWL.*

By

Maynie R. Curtis.

Introduction.

The oviduct of a laying hen is a large, much coiled tube filling a large part of the left half of the abdominal cavity. It is suspended from the dorsal body wall and lies dorsal to the abdominal air sac. Its anterior end is expanded into a large funnel which is spread out beneath the ovary in such a way that the mouth of the tube faces the ovary. In certain experimental work on the oviduct which has been for some time in progress in this laboratory, particular interest was aroused by the fact that when the oviduct is in functional (laying) condition the outer portion of its wall in the albumen secreting region is very thin. The main part of the oviduct wall is made up of the thick albumen and membrane secreting glands. The muscular and peritoneal layers are very thin, except in the region of the uterus and vagina. Notwithstanding this fact the oviduct is capable of very marked and long continued peristalsis. One is impressed with the fact that there is apparently a great disproportion between the amount of musculature in the walls of the duct and the degree of physiological activity of this organ. It seems to the observer impossible that so powerful a peristalsis can be maintained solely by so very thin a muscle layer.

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* Papers from the Biological Laboratory of the Maine Experiment Station. No. 16.

This apparent disproportion between structure and function led to the undertaking of the present investigation. It was desired to determine whether there did not exist some other muscular apparatus besides that intrinsic in the oviduct wall which could aid in the peristaltic activity of the organ. As a matter of fact it was found that there is a highly developed muscular apparatus in the ligaments of the oviduct. This musculature is directly connected with that which is intrinsic in the oviduct. Its existence at once gives the clue to the solution of the puzzle of the apparent disproportion between structure and function in the physiology of the oviduct. It appears that this disproportion is only apparent, not real.

The purpose of the present paper is, (a) to describe the ligaments which suspend the oviduct from the body wall, maintain the convolutions in the tube and hold the funnel in position to receive the mature yolks from the ovary, and (b) to describe the bundles of muscle fibers which occur in these ligaments and are continuous with the musculature of the walls of the oviduct.

The Development of the Oviduct and its Ligaments.

The relation of the oviduct to its ligaments is clear when studied in the light of its origin, development, and growth. The present study began with the oviducts of chicks just out of the shell but in order to make the relations of the duct more easily understood it will be well to begin the account with its origin. The embryological facts presented are taken from Lillie's* description.

The formation of the oviduct is preceded by the thickening of a strip of peritoneum on the surface of the Wolffian body immediately ventral to the Wolffian duct. This strip of thickened peritoneum, the tubal ridge, appears on the fourth day of incubation. It first arises at the anterior end of the Wolffian body and differentiates rapidly backward to the cloaca. Soon after its formation a groove appears at its cranial end. The lips of this groove fuse caudally forming a very short tube open cranially to the abdominal cavity and ending blindly behind. This tube soon separates from the tubal ridge. The lips of the

* Lillie, F. R. The Development of the Chick. New York (Holt), 1908.

opening into the body cavity form the funnel (*ostium tubae abdominale* or infundibulum) and the short tube forms the cranial end of the tubular portion of the oviduct. The rest of the oviduct arises by the caudal elongation of this short anterior portion which grows backward between the tubal ridge and the Wolffian duct to the cloaca.

As development proceeds the duct enlarges and begins to project from the ventral surface of the Wolffian body. The peritoneum of the tubal ridge which covers the duct becomes thin like the adjacent peritoneum. As development continues the oviduct projects farther from the surface of the Wolffian body which soon degenerates. The oviduct is finally suspended by a ligament formed by a double sheet of peritoneum continuous at the dorsal margin of the oviduct with the peritoneum which surrounds the duct and reflected from the peritoneum covering the dorsal body wall and permanent kidney along the line of origin of the oviduct. At the end of incubation this sheet of peritoneum which suspends and surrounds the oviduct is continued a little below the ventral margin of the oviduct as a narrow fold. The part of this sheet of peritoneum dorsal to the duct may be designated as the *dorsal ligament of the oviduct* (Fig. 1) and the part ventral, as the *ventral ligament of the oviduct** (Fig. 1).

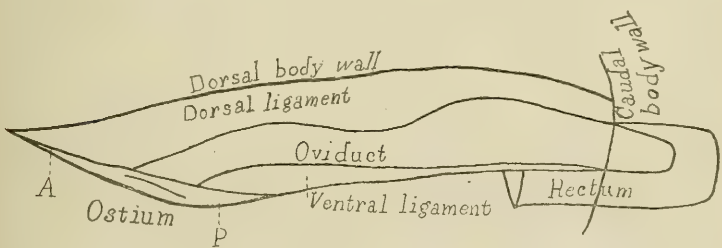

FIG. 1. Diagram showing relations of the oviduct and its ligaments at the time of hatching. *A*, anterior elongation of funnel; *P*, posterior elongation of funnel.

At the time of hatching the oviduct is still a straight thin walled tube somewhat differentiated into the parts clearly distinguishable in the functional duct. These are (a) the funnel

* This fold of peritoneum which forms the ventral ligament occupies the position described for the tubal ridge and it seems possible that this ridge may contribute to its formation.

(*ostium tubae abdominale* or infundibulum), (b) the albumen secreting portion, (c) the isthmus, (d) the uterus (or shell gland) and (e) the vagina. The walls are thin and soft and the tube empty and collapsed. The duct usually appears flattened laterally so that the ligaments are attached at the ends of its greatest diameter. At its anterior end the tubular portion of the oviduct spreads out into the funnel. The mouth of the funnel lies in a diagonal position, relative to the longitudinal axis of the bird (cf. Fig. 1). This arises from the fact that the dorsal margin of the tubular portion of the duct extends farther forward than does the ventral.

Since the tube is collapsed laterally its mouth is a narrow slit-like opening. The angles of this opening lie at the mid-dorsal and mid-ventral margins of the duct, or at the attachments of the dorsal and ventral ligaments. The funnel is short except at the angles of the mouth of the tube where it is extended into narrow tongues of tissue. The short portions of the funnel are extensions of the medial and lateral halves of the duct and are sometimes called the lips of the funnel. The elongations of the funnel which arise at the angles of its mouth are continuous with the duct at its dorsal and ventral margins, and thus at the attachments of the ligaments. The peritoneum which covers the external surface of these elongations is continuous with the peritoneum forming the ligaments, in the same way as is the peritoneum covering the external surface of the tube. The anterior elongation of the funnel does not extend straight forward in the cranial direction, but instead turns laterad, forming an angle of about 30 degrees with the sagittal plane of the animal. It is suspended from the anterior lobe of the left kidney and the dorsal body wall by the cranial end of the dorsal ligament. The posterior elongation of the funnel runs caudad parallel to the oviduct and is suspended from the ventral margin of the duct by the cranial part of the ventral ligament. These attachments of the elongations of the funnel spread it out beneath the caudal and lateral angle of the ovary. The significance of this fact will be discussed in a later section of the paper (p. 12).

The line of reflection of the dorsal ligament from the body peritoneum runs in a cranial direction a little to the left of the median line of the body from the caudal end of the abdominal

cavity, to the caudal end of the anterior lobe of the left kidney. At this point it turns slightly in a lateral direction, crossing diagonally the anterior lobe of the kidney. It continues in this direction to the fourth thoracic rib. This line of reflection is the dorsal margin of the ligament. The ligament begins to turn laterally at the level of the oviduct where the dorsal margin of the tubular portion of the duct passes into the anterior elongation of the funnel. Towards the cranial end of the dorsal ligament the distance between its attachment to the dorsal body wall, on the one hand, and to the funnel on the other hand, becomes gradually shorter. At the fourth thoracic rib the margin of the funnel itself is attached to the body wall. Thus the attachment of the funnel to the dorsal ligament forms the cranial margin of that ligament. Its ventral margin is its attachment to the tubular portion of the duct. Its caudal margin is its line of reflection from the peritoneum covering the caudal wall of the abdominal cavity.*

The relation of dorsal ligament and anterior elongation of the funnel of the oviduct to the abdominal air sac needs mention. At a point slightly mediad of the lateral margin of the kidney the line of reflection of the ligament reaches the part of the body wall to which the lateral margin of the abdominal sac is attached. From this point to the fourth thoracic rib the ligament and the anterior elongation of the funnel pass between the sac and the body wall. The elongation of the funnel projects into the sac and is surrounded by a fold of its wall. Usually even in young chicks this fold in the wall of the air sac is fused to the ligament. In some individuals the sac can be stripped off leaving the anterior elongation of the funnel suspended by the dorsal ligament.

In most cases these simple relations of the dorsal ligament exist essentially as described in just hatched or very young chicks. In some individuals at hatching, however, and in all cases examined at maturity, the peritoneum of the ligament is fused in certain places with the peritoneum of the air sac and mesentery. One such region of fusion has been described in

* In an adult hen the connective tissue core of the dorsal ligament extends through the layer of fat between the peritoneum and the caudal wall muscles. In this the ureter, blood vessels and nerves continue caudad.

the preceding paragraph. There is one other place where fusion takes place between the ligament and the dorsal wall of the air sac. This is a narrow strip along the dorsal margin of the ligament beginning where this structure passes between the sac and the body wall and extending caudad to the end of the sac. This fusion is often present in chicks just hatched and was found in all the specimens examined at sexual maturity. Fusion of the dorsal ligament and the mesentery is slight in extent and occurs only at the caudal end of the ligament between its medial surface and the lateral surface of the mesentery of the rectum.

The relations of the ventral ligament are always simple. Its dorsal margin is its line of attachment to the ventral margin of the oviduct. This margin extends as far craniad as does the tubular portion of the duct. Its cranial margin is its line of attachment to the posterior elongation of the funnel. At hatching the ligament is very narrow and nearly uniform in width throughout the greater portion of its course. It appears as a narrow band rounded slightly at the beginning of the funnel and limited ventrally at its cranial end by the posterior elongation of the funnel. Caudad to the end of the funnel the ventral margin of the ligament is free and slightly thickened. The two sheets of peritoneum forming the ligament are continuous at its free ventral margin. The ligament becomes narrower caudad and ends as a cord along the ventral margin of the uterus.

The Oviduct and its Ligaments in the Adult.

The ligaments of the oviduct always maintain the general relations described above. During the first four or five months after hatching the growth of the oviduct and its ligaments is about proportional to the growth of the rest of the body. With the approach of functional activity (egg laying) the isthmus, albumen secreting portion and funnel of the oviduct elongate considerably. This elongation includes the enclosing peritoenum. At their attachments to the duct the ligaments, of course, become elongated concurrently with the growth of the duct. At their opposite margins the ligaments do not elongate relatively but instead maintain the relations existing at the time

of hatching. In other words, the dorsal ligament maintains a line of attachment to the body wall running from the caudal end of the body cavity to the fourth thorasic rib. The free ventral margin of the ventral ligament elongates very little during the growth period, but becomes thick and muscular. The distance between the attachment of the dorsal ligament to the body wall and to the duct increases, varying somewhat in different regions of the duct. The width of the ventral ligament from its attachment to the oviduct to its free ventral margin increases during growth except at its caudal end. Here the ligament becomes simply a heavy mass of muscle. Thus at sexual maturity the oviduct is suspended in a fold of peritoneum which remains short at its dorsal and ventral margins but which is elongated where it encloses the duct.

The relation of the oviduct to the sheet of peritoneum which forms the dorsal and ventral ligaments as well as the outer covering of the duct itself was described many years ago by Macartney in his article on "Birds" in Rees' Cyclopaedia, Vol. IV. His description is as follows: "The ovarian tube or oviduct during the season of laying, fills the greater part of the lower belly; it forms a number of curves or convolutions similar to the intestines, which, however, are not permitted the same latitude of motion amongst each other, because the prolongation of peritoneum which includes the oviduct is remarkably strong, and is not so long as the parts it contains and therefore the convolutions are coiled close together and even some of them are doubled up within the peritoneum. The disproportion between the oviduct and the peritoneum, which invests it, arises from the additional bulk the [oviduct] * acquires when its functions are exercised whilst the peritoneum must preserve at its back part its original extent, i. e., the length of the left kidney, from the middle of which it is reflected."

As a result of the enlargement incident to commencing functional activity the albumen secreting portion and the isthmus are thrown into convolutions. The anterior and posterior elongations of the funnel increase in length. The peritoneum covering the uterus elongates very little more than is necessitated

* There is an obvious typographical error in the original text which here reads "ovary" instead of "oviduct."

by the growth of the body wall from which it is suspended.* In the region of the uterus the ventral margin of the dorsal ligament is only a little longer than its dorsal margin.

As a result of the growth changes which have been described in detail above both the dorsal and ventral ligaments of the oviduct come finally to have, in general, a fan shape. The truncated apices of the two "fans" are the dorsal and ventral margins of the dorsal and ventral ligaments respectively. The long, outspread borders of the "fans" are represented by the lines of attachment of the ligaments to the oviduct. The ventral ligament as a whole is strictly fan shaped. In the case of the dorsal ligament only the anterior portion is spread into a "fan." The fan shaped portion of the dorsal ligament is continuous caudad with the nearly straight portion which suspends the uterus.

The general relations of the ligaments which have been described are shown in Figures 6 and 7. Figure 6 shows the ventral ligament, and Figure 7 shows, besides a small portion of this, about three-fourths of the dorsal ligament (D). The method used in making the preparations from which these photographs were taken is described in a later section of the paper (p. 9).

At the functional period the ligaments are very vascular. In the region of the oviduct the large vessels break up into branches which pass forward and backward on the oviduct, often anastomosing with other branches either in the ligaments or on the walls of the oviduct.

The Musculature of the Ligaments of the Oviduct.

Early in the study of the ligaments of the oviduct it became clear that these structures contained a very considerable amount of smooth muscular tissue. Special attention was then devoted to a study of the character and distribution of this musculature.

At first histological sections were employed, but large surface mounts of the ligaments and adjacent oviduct walls also proved very valuable in determining the origin, direction and distribu-

* The glandular surface of the uterus is increased by the elongation of the inner layers of the oviduct which are thrown into folds within the peritoneum.

tion of the muscle bundles. For such preparations oviducts were removed by cutting the peritoneum lining the dorsal body wall a little to either side of the line of reflection of the dorsal ligament. This peritoneum was then stripped off the body wall and kidney. One-half of the oviduct was then cut away at its dorsal and ventral margins leaving the other half attached to the ligaments. The portions of the duct and ligaments desired for study were selected. From these the glandular part of the wall of the oviduct was removed by careful scraping. By exercising sufficient care in this operation it is possible to remove practically all of the glandular part of the wall, and leave the underlying muscular and peritoneal layers intact.

Such preparations were fixed in two different ways. When the specimen was intended for microscopic study it was carefully spread out on a wax bottomed dissecting pan and exposed to the action of osmic acid vapor for from 15 to 20 minutes. The hardened sheet of tissue was then washed for 3 or 4 hours in running water, then stained in picro-haematoxylin (Conklin), dehydrated, cleared in cedar oil and mounted in balsam between ordinary "3¼x4" lantern slide covers. Specimens to be used for macroscopic examination, and to be photographed (cf. figures 6-9), were fixed in Gilson's mercuro-nitric fluid after first being carefully stretched in a wax bottomed dish. The time of fixation was from 18 to 24 hours. This method of fixation renders the muscle fibers white and when treated with alcohol the other parts of the ligament become nearly transparent. When these preparations are placed against a black background the muscle bundles and blood vessels stand out very sharply. Such Gilson specimens were usually not permanently mounted but simply spread out on a black background for study or to be photographed.

By means of these various preparations it was possible to determine the extent of the musculature of the ligaments and the relation of this to the intrinsic musculature of the oviduct. This musculature is best developed and hence easiest studied when the hen is in laying condition.

The muscle fibers of the dorsal ligament have their origins in a line near the medial side of its dorsal margin. Here the bundles of muscle fibers are quite large but as they pass ventrad toward the duct they spread out in the ligament, breaking up

into smaller bundles. These smaller bundles anastomose frequently as they approach the oviduct (figures 7, 8 and 9). At the attachment of this ligament to the oviduct these bands of fibers continue around the duct. Most of them pass to the medial side (figures 8, 9.).

The free ventral margin of the ventral ligament in the laying hen is a solid muscular cord 3 to 6 mm. in diameter. This cord becomes heavier toward the caudal end of the ligament. From this cord bundles of fibers extend on either side toward the oviduct in much the same way as has already been described for the muscle bundles on the medial side of the dorsal ligament. These fibers continue around the oviduct. Some of the fibers pass to the medial and some to the lateral side of the duct.

Most of the above points are shown in the preparations of which figures 6-9 are photographs. Figures 6 and 7, which have been used to show the shape of the ligaments at sexual maturity also show the musculature of the ligaments. Figure 6 is a photograph of the ventral ligament. It shows the heavy muscular cord at the free ventral margin. This cord is much heavier at the caudal than at the cranial end. From this cord the interwoven bundles are seen separating, breaking up into smaller bundles and spreading out in the ligament as they pass toward the oviduct. Near the margin from which the duct has been cut many of the fibers are seen anastomosing.

Figure 7 shows the origin of the separate muscle bundles near the dorsal margin of the dorsal ligament. This photograph is taken from the lateral side of the duct so that the muscle origins here show through the air sac wall and the peritoneum of the lateral side of the ligament. These bundles are seen breaking up into smaller bundles and the small bundles are seen anastomosing as they pass to the duct. In the anterior portion where the funnel and anterior end of the duct are attached some of the muscle bundles can be followed as they pass onto the wall of the duct.

Figures 8 and 9 are photographs of opposite sides of the same preparation. This preparation is a piece of the medial half of the caudal end of the isthmus and the attached ligaments of the oviduct of a laying hen. The lateral half of the oviduct has been removed and the glandular layer scraped from the medial half. Figure 8 is a photograph of the lateral aspect

of this preparation. The dorsal ligament lies toward the top and the ventral ligament toward the bottom of the photograph. The left margin is the anterior end of this piece of the oviduct and ligaments. The heavy muscular mass which shows at the bottom of the photograph is the caudal end of the free margin of the ventral ligament. From this the fiber bundles pass out into the ligament and separate into smaller bundles as the oviduct is approached. The cut ends of some of the fiber bundles appear, rather indistinctly, where the lateral wall of the duct was cut away. Some of the bundles can be traced onto the medial wall of the oviduct where they lie below the circular fibers which also appear in the photograph. In the dorsal ligament most of the muscle fibers lie below the blood vessels but some of them accompany these vessels. At the margin of the oviduct many of these fibers can be seen passing beneath the layer of circular fibers.

Figure 9 shows the medial aspect of the same preparation figured in Figure 8. The dorsal ligament lies toward the top and the ventral toward the bottom as before. In Figure 9, however, the anterior end of the preparation lies to the right. The continuation of the muscle bundles from the ligaments to the duct show more clearly than in Figure 8 since they here lie above the intrinsic circular fibers of the duct. The fiber bundles in the dorsal ligament show above the blood vessels. The origins of these bundles are seen near the dorsal margin of the ligament. The origin of a number of the bundles shown in this preparation are crowded together near the center of the part of the dorsal margin which is shown here.

Sections of a young oviduct with the ligaments attached show these bundles of muscle fibers arranged in layers near the peritoneal surfaces of the ligaments. These layers of muscle bundles are continuous with the outer muscular layer of the wall of the oviduct. The ventral ligament, as has been noted, has a heavy mass of muscle bundles near its free margin. This mass of muscle separates into two distinct layers, one near the peritoneum of each side of the ligament. At the ventral margin of the duct these muscle layers continue around it, each preserving the same relation to the peritoneum which it has in the ligament In chicks up to 4 months old, at least, the two layers of muscles which pass to either side of the duct are

nearly equal in thickness. In the dorsal ligament, however, the majority of the muscle bundles are in relation to the peritoneum on the medial side of the ligament and are continuous with the muscle layer on that side of the oviduct.

From the facts which have been brought out in this section it appears that in the domestic fowl the outer muscle layer of the oviduct is continuous with the muscle fibers from the ligaments. This is similar to the condition in mammals where the outer longitudinal layer of muscle of the uterus develops from the muscle fibers in the broad ligament.*

THE NORMAL RELATIONS OF THE CRANIAL END OF THE OVIDUCT AND ITS LIGAMENTS TO THE OVARY, AND THE SIGNIFICANCE OF THESE RELATIONS.

In all vertebrate animals the ovum at the time of ovulation is, theoretically, cast off from the ovary into the abdominal cavity. From the abdominal cavity it must get to the outside through the oviduct. It is obviously of the highest importance that the ovum should practically never fail to get into the oviduct. There exist among the different vertebrate classes a whole series of different structures and modes of physiological behavior, if this term may be used, apparently adapted to ensure this result. Thus in mammals the fimbriated funnel of the Fallopian tube wraps itself around the ovary at ovulation in such a way that while theoretically the egg drops from the ovary into the abdominal cavity, practically it drops into the oviduct.

In the course of the present anatomical study it has been found that the normal visceral relations in a laying hen are such that the ovary is practically walled off by peritoneal surfaces from the rest of the abdominal cavity. Practically the only line of egress from the "ovarian pocket" presently to be

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* Cf. Kreitzer. Anatomische Untersuchungen über die Muskulatur der nicht schwangeren Gebärmutter. Land. Beitr. zur Anat. und Histol. St. Petersburg, 18[illegible]

Heyken, G. Anatomische Untersuchungen über die Muskulatur der breiten Mutterbänder. Gekr. Preisschr., Inaug.—Dissert. Kiel, 1890.

An excellent general account of this mammalian musculature is given in Nagel, W., Die weiblichen Geschlechtsorgane, in Bardeleben's Handbuchs der. Anatomie des Menschen, 7 Bd, II Teil, 1 Abteilung. Jena (Fischer) 1896.

described, is through the *ostium tubae abdominale* of the oviduct. In other words it is easy of demonstration that so far as the *anatomical* relations are concerned, an egg discharged from the ovary cannot get far away from the funnel of the oviduct. Without any reference to the *activity* of the funnel itself the eggs separated from the ovary would as a mechanical necessity from the normal anatomical relations be brought close to its mouth. It is the purpose of this section to describe these relations and to show how this "ovarian pocket" is formed.

The walling off of the ovary in the hen is effected by the left abdominal air sac and a part of the intestine and mesentery. These structures in their mutual relations form what may be called a "pocket" in which the ovary lies. The dorsal wall of this "pocket" is formed by the body wall to which the ovary is attached. The ventral wall of the "pocket" is formed by the dorsal wall of the air sac. The medial, cranial and lateral limits of the pocket are formed by a fusion of the wall of the air sac to the mesentery and body wall. Caudad the boundary is composed of the transverse part of the small intestine and the caudal portion of the left coecum with their attached mesentery and peritoneum. There is a small open space dorsal to the junction of the left coecum and rectum and lateral to the rectum. In this space lies the mouth of the funnel. The oviduct which lies to the left of the rectum and its mesentery here passes into the funnel.

The detailed description of these relations follows. The left abdominal air sac extends from the anterior end of the abdominal cavity as far caudad as a line connecting the caudal end of the gizzard with the caudal end of the pubis. It is as wide as the left half of the cavity extending from the mesentery to the lateral body wall. This sac is attached in a band around its medial, cranial and lateral margins. Its caudal margin and dorsal and ventral surfaces are free. Mesially this attachment is to the mesentery connecting the left coecum to the dorsal margin of the gizzard and also to the mesentery of the proventriculus, or glandular portion of the stomach. At the anterior end of the body cavity the attachment of the air sac passes to the body wall and runs in front of the anterior end of the ovary and suprarenal body. At the craniolateral angle of the body cavity the band of attachment passes in a widening belt along

the lateral side of the ovary and oviduct as far backward as the caudal margin of the sac. This lateral attachment of the sac is to the kidney, dorsal oviduct ligament, and body wall.

The air sac thus forms a partition to the body cavity complete as far caudad as it extends.* Ventral to the sac lie the left lobe of the liver, the proventriculus, the spleen and the gizzard, while the cavity dorsal to the sac contains the ovary and parts of the intestine and oviduct. In the normal condition the sac contains little air and clings to the organs which lie dorsal to it. The ovary occupies the anterior end of the cavity dorsal to the sac. Since the attachment of the air sac passes along the medial, cranial and lateral margins of the ovary, this organ is walled off from the other viscera in all directions except caudally by the anterior portion of this sac.

The caudal relation of the ovary to the rest of the viscera depends on its size. It changes as the ovary enlarges with the approach of a laying period or egg cycle. In pullets and hens not in laying condition the reproductive organs are small and the other viscera occupy most of the abdominal cavity. A part of the intestines crowd forward between the ovary and the air sac. The viscera normally found in this position are the transverse part of the small intestine and that portion of the left coecum which lies parallel to it.† The mesentery of this part of the intestine is reflected from the body wall just caudal to the attachment of the ovary. Mesially it is fused with the mesentery of the proventriculus and laterally it is con-

* Butler (Proc. Zool. Soc. London, 1889, pp. 452-474, Plates XLVI-XLIX) describes and figures on both sides in both sexes of the chick a partition which he calls the *oblique abdominal septum* or the *anterior part of the post hepatic septum.* He shows by a study of the embryology that this septum develops in connection with the abdominal air sacs which grow between and separate its two layers of peritoneum. In the adult this septum is apparently represented by the peritoneum covering the sacs. He does not discuss the relation of this partition to the viscera but his figures show the gonads lying dorsal to it. On the left side of the female they show the ovary shut off from the viscera by the sac. In the present paper this partition of the left side of the female is described as it appears in the adult, i. e., as the left abdominal air sac.

†In two individuals this part of the intestine and coecum was found to lie caudal to the ovary and dorsal to a loop of the small intestine which projected forward ventral to the ovary. In neither of these cases were there large yolks on the ovary.

tinuous with the mesentery of the rectum at the junction of the small intestine and rectum. The coeca lie parallel to the most caudal portion of the small intestine, to which they are attached by peritoneum. They enter opposite sides of the rectum just behind the ileocolic valve. Where the coeca parallel the transverse part of the small intestine the left one lies craniad and ventrad to the intestine. The right coecum lies caudal and dorsal to it. The left coecum thus lies farther forward on the ovary than does the intestine.

When a laying period is approached the growing yolks on the ovary crowd the viscera caudad. The intestine and coecum are forced backward and downward from the ovary. The mesentery of the intestine, the intestine itself, the peritoneum joining the left coecum of the intestine, and the left coecum itself, form a partition between the ovary and the other viscera. This partition is incomplete dorsal to the end of the left coecum and lateral to the anterior end of the rectum. This space is at the caudolateral angle of the ovary and here the mouth of the funnel is spread out facing that organ. It is thus in the position most advantageous to receive the mature yolks.

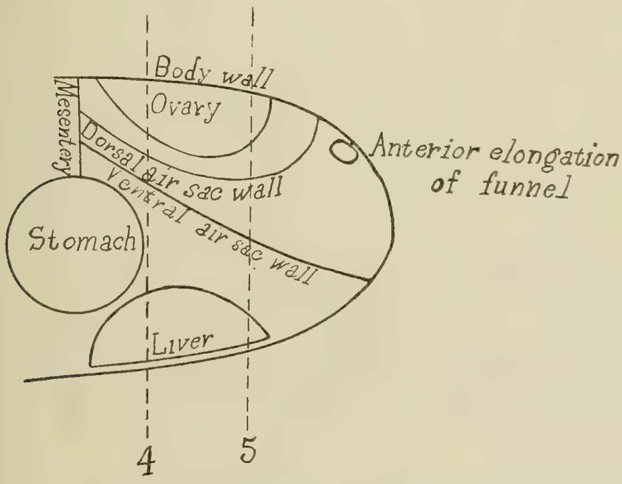

FIG. 2. Diagram of a cross-section of the left half of the body of a hen in a plane cranial to the mouth of the funnel of the oviduct.

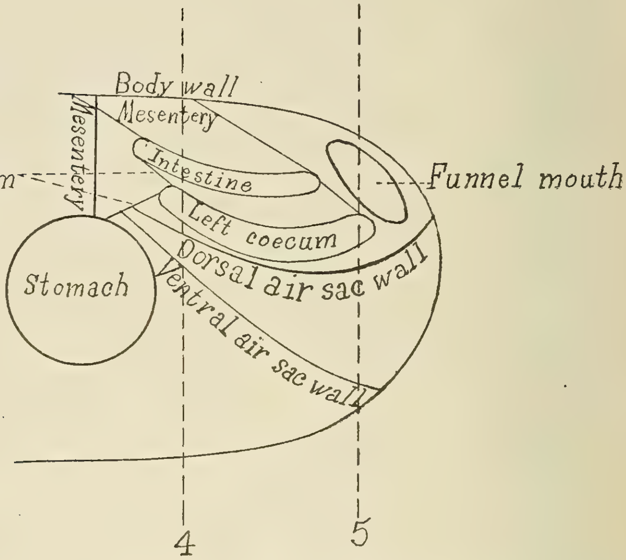

FIG. 3. Like Fig. 2, but showing the relations of the viscera in a plane just caudal to the ovary and through the mouth of the funnel of the oviduct.

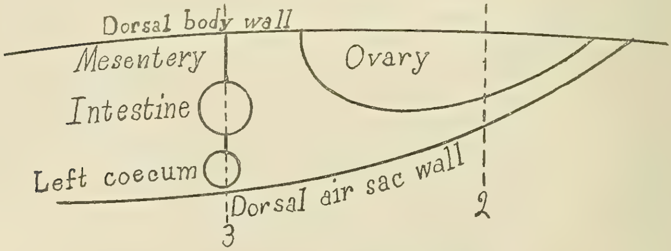

FIG. 4. Diagram of a portion of a longitudinal section through the left side of the body of a hen. The plane of section is slightly mediad of the funnel mouth.

Figures 2, 3, 4, and 5 are diagrams representing the relation of the ovary to the air sac, the intestine, the left coecum and the mesentery, and to the mouth of the funnel. Figure 2 represents a cross section near the anterior end of the sac. It shows the ovary lying dorsal to the sac which is attached to

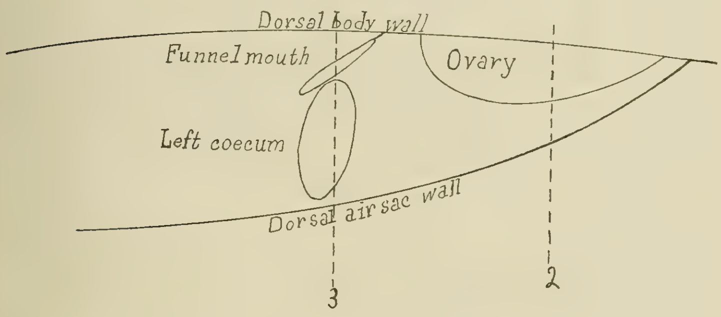

FIG. 5. Like Fig. 4 except that the plane of section is here farther laterad and goes through the funnel mouth.

the mesentery and lateral body wall. The anterior prolongation of the funnel lies between the air sac and the body wall lateral to the dorsal line of the band of attachment of the sac. Figure 3 is a diagram of a cross-section caudal to the ovary through the coecum, intestine and mesentery, which wall off the ovary caudad. It shows the coecum lying against the dorsal wall of the sac and connected to the transverse part of the small intestine; the transverse part of the intestine with its mesentery; the fusion of this mesentery with the mesentery of the stomach; and the peritoneal connection of the coecum to the dorsal wall of the gizzard, to which the medial margin of the air sac is here attached. The mouth of the funnel is shown dorsal to the end of the coecum and lateral to the intestine and its mesentery.

Figure 4 represents a longitudinal section through the "ovarian pocket" mediad of the mouth of the funnel. It shows the ovary lying dorsal to the air sac and walled off behind by the coecum and intestine with their attached peritoneum and mesentery. Figure 5 represents a similar longitudinal section through the mouth of the funnel. It shows the ovary dorsal to the wall of the sac and the funnel caudal to the ovary and dorsal to the end of the coecum.

The dotted lines numbered 4 and 5 in figures 2 and 3 represent the planes of the sections shown in figures 4 and 5 respectively. The dotted lines numbered 2 and 3 in figures 4 and 5 represent the planes of the section shown in figures 2 and 3 respectively.

The walling in of the ovary in all directions except the one occupied by the mouth of the oviduct in the manner described must tend to decrease the chance of yolks getting free in the body cavity. Even with this arrangement such an accident sometimes happens. In autopsies of a large number of laying hens in a few cases yolks have been found among the viscera. Tumors which appeared to be formed around such yolks have also occasionally been found. It is not possible with our present knowledge to draw conclusions as to the extent of this apparent structural adaptation among birds. Even in the species where the air sacs have been carefully studied, the description of their attachments and position in relation to the viscera have not been given in detail. From such descriptions as exist it appears that the left abdominal air sac does not uniformly isolate the genital organs so completely as is here described for the domestic fowl.

Owen* states that "the air receptacles of the thoracic-abdominal cavity present varieties in their relative sizes and modes of attachment in different birds" (meaning different species). Muller ** states that in the pigeon the walls of the abdominal air sacs are almost entirely free. Baer† has demonstrated that the abdominal air sacs are absent in the cassowary. Data are wanting as to whether the oblique abdominal septum of Butler occurs in these cases. It is possible that this septum occurs throughout the class *Aves* even when the abdominal air sacs bear other relations than those described in the domestic fowl, or even when they are absent.

The general result of this section of the paper is to show, with detailed anatomical description of the relations involved, that there is formed in the hen a sort of "pocket" in which the ovary lies. This "pocket" is of such a nature that, quite apart from any physiological activity on the part of the funnel of the oviduct, the ova separated from the ovary at ovulation are mechanically directed towards the funnel mouth.

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* Owen, R. On the Anatomy of Vertebrates. Vol. II. Birds and Mammals. London (Longmans) 1866.

** Müller, B. The Air Sacs of the Pigeon. Smithsonian Misc. Col. Quarterly Issue, Vol. 50, Part 3, No. 1724, pp. 365-414.

† Baer, M. Beiträge zur Kenntnis der Anatomie und Physiologie der Atemwerkzeuge bei den Vögeln. Ztschr. wiss. Zool. Bd. 61.

SUMMARY.

This paper presents the results of a detailed anatomical study of the ligaments of the oviduct of the domestic fowl.

It is shown that the dorsal and ventral ligaments undergo a progressive change in shape and size relations as the oviduct enlarges in preparation for functional activity. The character of these changes is described.

It is further shown that the ligaments of the oviduct possess a definite and well developed musculature which is continuous with the outer muscular layer of the oviduct. The physiology of this musculature of the ligaments is now under investigation in this laboratory.

Finally it is shown that the mutual relations of the abdominal viscera are such as virtually to form a "pocket" in which the ovary lies. This walling off of the ovary is of such character as to tend mechanically to direct detached ova to the mouth of the oviduct.

DESCRIPTION OF PLATES.

Figure 6. A photograph of the ventral ligament of the oviduct of a laying hen showing its form and musculature. The ragged outer border is the cut dorsal margin, i. e., the margin along the oviduct. The short smooth border in the center of the photograph is the free ventral margin. The thin cut surface extending from the ventral to the dorsal margin of the ligament is the anterior margin cut along its attachment to the posterior elongation of the funnel. The thick wedge-shaped portion which shows at the opposite end of the ventral margin is the caudal end of the ligament cut from the anterior end of the uterus. This photograph is natural size.

Figure 7. A photograph showing the form and musculature of the funnel, a short portion of the tubular part of the oviduct, and the anterior portion of both ligaments removed from a laying hen. The dorsal ligament is shown for about three-fourths of its length. The lateral half of the oviduct is cut away along the attachment of the ligaments. The glandular layer of the duct was scraped away (cf. p. 9) in the tubular portion of the duct leaving only the muscular and peritoneal layers.

The significance of the letters in this figure is as follows: A, anterior elongation of funnel; P, posterior elongation of funnel; F, funnel (*ostium tubae abdominale*); D, dorsal ligament; O, one half (left) of wall of anterior tubular portion of the oviduct, from which the glandular part of the wall has been removed by scraping; S, portion of the air sac wall.

The anterior margin of the dorsal ligament shows along the attachment to the anterior prolongation of the funnel. The ventral margin shows along the attachment to the tubular portion of the duct as far as this goes, and then as a cut edge from which the duct has been removed. In order to spread the dorsal ligament out flat in this preparation a cut was made near the posterior end of the dorsal margin extending about half way to the ventral margin. This cut shows just to the right of the end of the anterior elongation of the funnel.

A portion of the wall of the air sac (S) which is fused to the dorsal part of the ligament is left attached. It is spread back toward the dorsal margin of the ligament and is so transparent that it shows only beyond the margin of the ligament and between the edges of the cut made to flatten the latter. The ventral margin of the band of fusion can be distinctly seen. This photograph is about four-fifths natural size.

Figure 8. A photograph showing the musculature of the medial half of the caudal end of the isthmus and the portions of the dorsal and ventral ligaments which attach to it. The lateral half of this portion of the duct was removed by cutting it along the attachment of the dorsal and ventral ligaments. The glandular layer of the oviduct was scraped away leaving only the muscular and peritoneal layers. In the photograph the dorsal ligament lies above and the ventral ligament below the oviduct. The anterior end of the preparation lies to the left. This photograph shows the lateral aspect of the preparation. Natural size.

Figure 9. A photograph of the medial aspect of the same preparation shown in lateral view in Figure 9. The dorsal ligament lies above and the ventral ligament below the oviduct as in figure 8. The anterior end of the preparation lies to the right. Natural size.

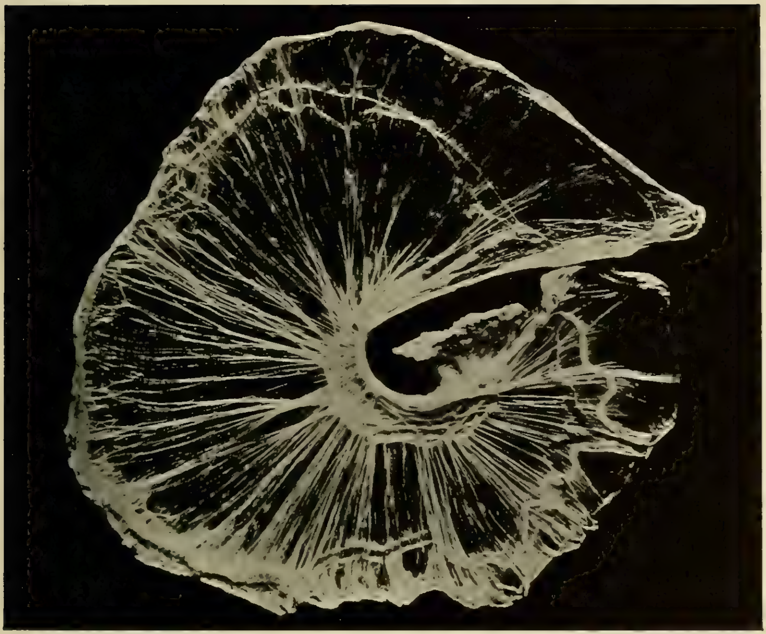

FIGURE 6

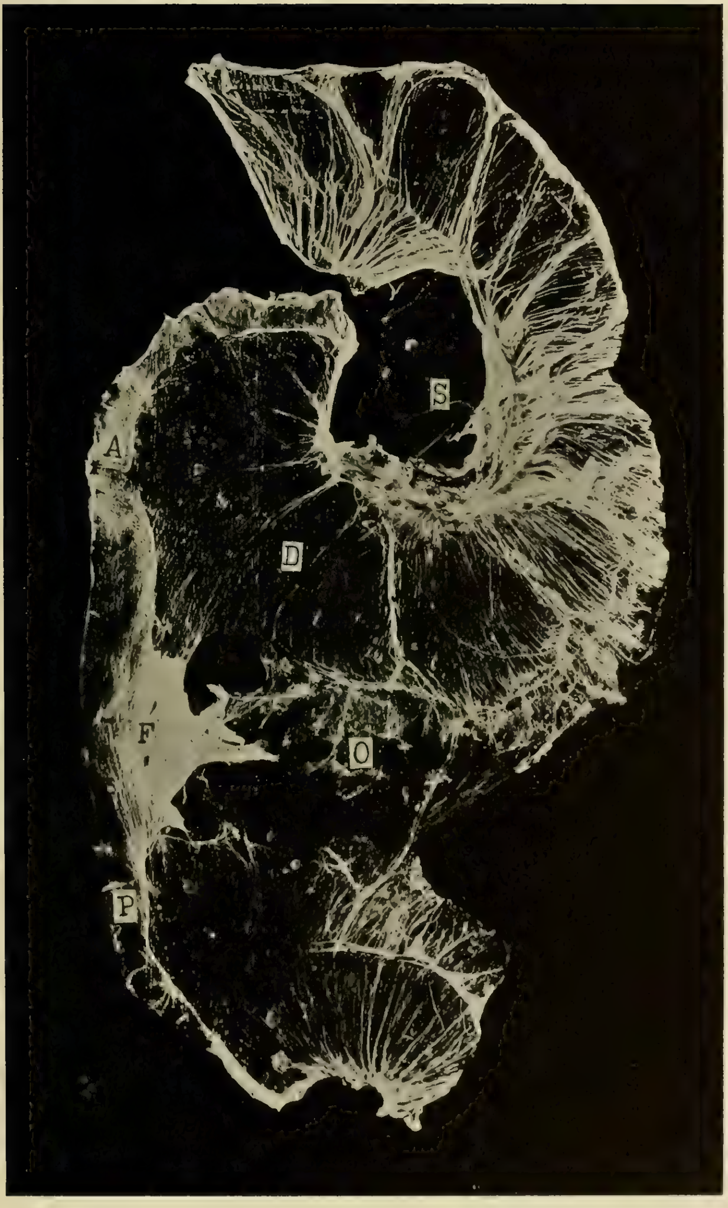

FIGURE 7

FIGURE 8

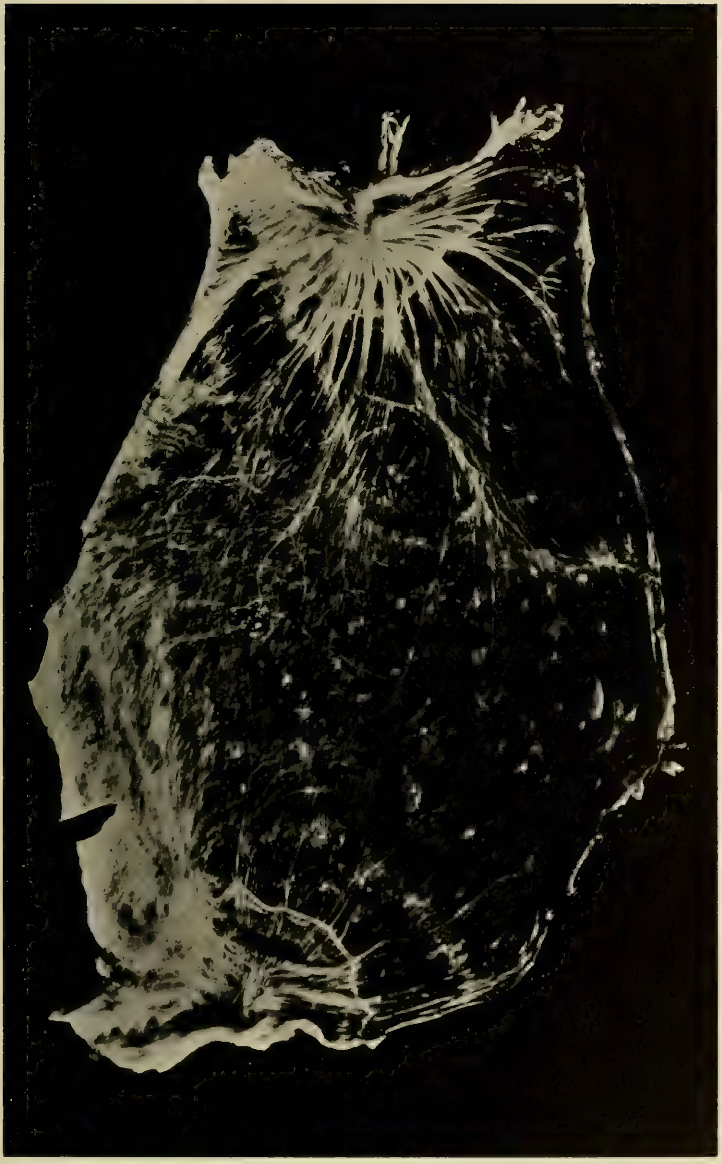

Figure 9

BULLETIN No. 177.

INSECT NOTES FOR 1909.*

Oskar A. Johannsen.

A miscellaneous lot of notes comprising both new observations, notices of species dealt with more fully in other publications, and mere statements of insect situations fall conveniently into an annual bulletin under the title of *Insect Notes*. In this publication compilations and remedial measures are both avoided for the most part, as the economic necessity for either of these is met by illustrated descriptive circulars more satisfactory to the people of the state who submit the standard troublesome insects for determination.

The briefer notes of miscellaneous character found in this bulletin are transferred with a little editing from the entomological note books of the department. The Lot numbers here given are merely references to Station records for the species in question and have no significance beyond permanently linking the published account to the Station collection and notes, which is in some cases desirable.

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* Papers from the Maine Agricultural Experiment Station: Entomology No. 41.

LEPIDOPTERA.

(Butterflies and Moths.)

Forest Caterpillars.

Heterocampa guttivitta (The Saddled Prominent).

As during 1907 and 1908, the Saddled Prominent caterpillar was exceedingly destructive to beech and other deciduous forest trees during the summer of 1909, and many areas were entirely stripped of their leaves. The total amount of damage, however, was conspicuously less than during 1908, as would be expected from the wholesale death of this species from fungus disease over extended areas late the previous season. This remarkable outbreak of a species usually not troublesome is fully discussed in Bulletin No. 161 of this Station. For the past season there is little general information to add except to state that the trouble was very much less serious last summer.

Other species have been very destructive in forest and shade trees during the summer of 1909 as was the case for the two previous seasons, for Maine has experienced three consecutive caterpillar summers. The Green-striped Maple-worm (*Anisota rubicunda*), the Rosy-striped Oak-worm (*Anisota virginiensis*), and the White Tipped Moth (*Symmerista albifrons*) were especially guilty. These received a fuller discussion in Bulletin No. 162 of this Station last year.

Acrobasis rubrifasciella, a species abundant for several seasons in Sweet fern (*Myrica asplenifolia* L.), constructing in a tangle of leaves curious trumpet shaped cases, was very generally numerous again during the past summer. It was, however, attacked by parasites in great numbers during 1909.

Hyphantria cunea, the Fall Web-worm,* a common orchard pest, was so unusually abundant upon orchard, shade and forest trees as to rank among the conspicuous pests of 1909, the unsightly webs being met with everywhere. Attendant parasites were common.

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* A descriptive economic circular is available to applicants.

Achatodes zeae (Spindle worm).

In June the new shoots of the elder may be found to be withered and dying and if the twig be cut open a white caterpillar with black spots may be seen feeding upon the pith. This is the spindle worm, the larva of the little moth *Achatodes zeae*. The species, first described by Harris, and well known to systematists, has rarely since been mentioned by economic entomologists. Besides the elder, it also is injurious to corn, dahlia, and perhaps other thick-stemmed plants. In the elder twigs the caterpillar when full grown gnaws towards the surface at some point, usually near a twig node, pierces the bark or leaves a thin layer unbroken, then pupates within its burrow. The adults emerge in July and August. We have reared specimens at Orono, Maine, bearing the date August 6, and also have specimens from Ithaca, New York, which emerged July 14. According to Forbes the adults in Illinois appear the latter part of June.

The full grown caterpillar, which is about one inch long, is yellowish white in color with flat blackish tubercles each with a single bristle. On the first and second abdominal segments the tubercles are arranged as follows: one on each side of the mid-dorsal line, a second behind and below this, four grouped around the spiracle of which the third is above and slightly in front of it, the fourth behind, the fifth very small, in front and above, the sixth directly below it; the seventh to the tenth are on the ventral side of the segment, the eighth being very much smaller, and the seventh of the first segment bears two bristles. In some specimens and on some segments the third and fifth tubercles are nearly or quite fused. The preanal and the anal plates (fig. 26) are contiguous but not fused. The hooks of the abdominal legs are uniform in size, about 22 in number, the circle being widely open outwardly. The palpi of the second maxillae are short and thick (fig. 24).

The pupa is reddish brown in color, over half an inch in length, at the head end with two stout rounded tubercles, the posterior end with the stout spines (fig. 27). The adult, which expands over an inch, has rust red fore wings mottled with gray, with orange spots near the tip, and yellowish gray hind wings. It is figured by Holland in his Moth Book.

Bucculatrix canadensisella (The Birch leaf Bucculatrix).

During the first week in September the leaves of the white and yellow birch in various parts of the State were much injured by the caterpillar of the Birch leaf Bucculatrix. The injured leaves (fig. 19) had much of the green parenchymal tissue eaten away, leaving only the epidermis of one side as a transparent film, and even this was found pierced here and there. Every birch in sight seemed to be infested and had a brown and scorched appearance, visible even at a great distance.

The full grown caterpillar is less than ¼ of an inch in length, of slender form, with deep incisures between the rounded segments. The head is pale brown; the body, dull pale yellowish green. The first and second abdominal segments each have six pairs of rather long bristles besides a few very minute ones; the bristles of the following segments are somewhat similarly arranged. There appear to be no distinct tubercles, nor is there an anal fork. Each abdominal leg has 3 pairs of claws (fig. 36); except the anal legs have but one claw each (fig. 37). The palpi of the second maxillae are slender, each provided with long bristles. The other mouth parts are as figured (33-35).

The molting cocoons are small, circular, white, silken patches in which the larva lies curled up and may be found on the surface of the leaf (fig. 19) and also on the under side of twigs and branches. When the larva has attained its full growth the true pupal cocoon is formed. This is an oval yellowish body with flat base and with 5 or 6 sharp longitudinal ridges. These cocoons have been found on the twigs and leaves but as comparatively few are present there it is evident that the greater number of larvae pupate elsewhere. The moths which have a spread of wing of ⅜ of an inch have dusky wings crossed by several silvery white bars. They appear in early spring. While the larvae attack the Birch by preference we have found them on Red Oak also.

For ornamental trees, a weak arsenical spray applied early in August has been recommended. (Lot 793.)

Gypsy and Brown-tail Moths.

On account of the seriousness of the Brown-tail Moth and Gypsy Moth situation these two insects should be constantly

held in mind by the people of the State. In response to our request, Mr. E. F. Hitchings, State Entomologist, has kindly sent us a brief statement which we give here in full concerning the work with these two insect pests which is being carried on under the supervision of the State Department of Agriculture.

"The gypsy moth situation in Maine at the close of the year 1909 is serious in the extreme. Although the field work, under the direct management of the special field agent, Capt. E. E. Philbrook, has been conducted with the same painstaking methods as in the past, yet, owing to an extended territory, opened up for the first time by the scout made in the early part of the season, and to the fact that not enough funds were available to supply a sufficiently large force, the efficiency of the work has been curtailed and we are now facing a very serious crisis. If it had not been for the assistance of the Federal Government the pest would have gained a foothold that would defy our best efforts to control. The situation is a grave one and should enlist the hearty cooperation of every good citizen of the State. The moth is a menace to our northern woods, and those interested should see to it that sufficient aid is rendered to check its onward march northward. York County is still the fighting ground, although one small infestation has been found at Gorham this fall."

Brown-tail Moth Outlook.

"In the southern counties of the State where this pest was first introduced, it is a serious menace to the summer people who come to us for rest and recreation. Many cases of "brown-tail rash" proved quite serious during the past summer, and one of the scouts who was very badly afflicted died. The ravages of the moth can be controlled on the fruit and shade trees by spraying, but this is a very expensive method, especially for the shade trees. Gathering and burning the winter nests for such trees should be annually practised. The spread northward has been all along the line. The moths were found in Madison during the summer and nests were taken at Sangerville during the spring. A scout was made in Bangor and vicinity with the result that nests were taken the entire length of the electric line from Hampden to Old Town and in Brewer. All nests should be removed and burned at the earliest moment."

Fruit Tree Caterpillars.

Ancylis (Phoxopteris) nubeculana, the apple leaf sewer.

From Enfield, Maine, August 28, and later also from other localities come reports of injury to the leaves of several varieties of apples. The leaf is folded along the mid rib, the two sides being brought together, the caterpillar constructing its nest within (fig. 18). The winter is passed in the larval condition in the folded leaves which lie on the ground. In April the larvae transform to chrysalids and about 10 days later the moths begin to appear, laying eggs in June. The caterpillar is about ½ inch in length when full grown, yellowish green, with yellow head, and horny shield on the next segment a little darker, with a black dot on each side. On each of the remaining segments there are some pale, shiny, raised dots (tubercles) from every one of which arises usually a single hair. The tubercles of the first and second abdominal segment are arranged as follows: one on each side of the middle dorsal line, the second behind and below this, the third above the spiracle, the fourth and fifth below the spiracle and fused, the sixth below and behind these, below this is the seventh with 2 or 3 bristles, and the eighth near the central line on the ventral surface. The claws of the abdominal legs, over 40 in number, alternately long and short, are arranged in an unbroken circle. The anal plate bears 4 long bristles and is widely separated from the preanal plate which is small and bears 2 bristles. The anal fork (fig. 32) has 6 tines, the middle 4 slightly bifid at the apex. The mouth parts are shown in figures (28, 29, 31). The palpi of the second maxillae are quite slender, each with a long terminal bristle.

When the injury to the tree is serious the fallen leaves may be raked up and burned in the autumn to restrict the development of the moth the following season. (Lot 792.)

Coleophora fletcherella (Cigar case bearer).

The cases of this insect were gathered at Highmoor Farm near Monmouth, Maine, June 24. The small caterpillars which live in cigar-shaped cases feed from April to June on the buds and foliage of apple trees. The little gray moths appear from

the middle of June to middle of July or a little later, lay eggs, which hatch in about two weeks. The young, which are leaf miners, soon make cases, which they later attach to the bark, thus passing the winter, beginning to feed again early the following spring. If the trees are sprayed for the codling moth the case bearers are also destroyed. (Lot 762.)

Enarmonia prunivora (Lesser apple worm).

As we have no Station records of the occurrence of this insect in Maine, it may be of interest to note that a number of specimens of this species was reared August 5-9 from a lot of small apples obtained June 30 from an orchard at Oxford, Maine. The owner of the place reported very serious injury to his crop due to this insect as well as to the codling moth (*Carpocapsa pomonella*) and the plum curculio.

According to Fletcher and others this insect also attacks haws, crabapple, plums, and elm and oak galls. The larva feeds upon the apple in a manner similar to that of the codling moth, for which it is doubtless frequently mistaken. Besides by its smaller size the larva may be distinguished from that of the codling moth by the presence of the anal fork. The adult moth expands about ⅝ of an inch across the wing. The ground color of the front wings is black, with patches of pale rusty red, of gray, and of yellowish white and steel blue oblique lines. The hind wings are dusky gray at the base, shading to black at the apex.

The insect may be combatted by methods used against the codling moth. (Lot 785.)

Garden Caterpillars.

The woolly bear caterpillars, *Estigmene acreae,** and *Diacrisia* (*Spilosoma*) *virginica** have caused much damage to garden crops, taking practically anything from peas to onions, and to flower gardens. Though very troublesome, neither of these hairy caterpillars were as numerous as during 1908.

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* A descriptive economic circular is available to applicants.

HEMIPTERA.

(Bugs.)

San Jose Scale in Maine.

The following particulars concerning this pest are given by Mr. E. F. Hitchings in answer to our inquiry.

"A single infestation of this most dreaded of all orchard pests is situated in the town of Limerick. As near as can be ascertained it was introduced about 8 years ago on one or more apple trees procured from a New York nursery. The spread is confined to some 20 trees in a rather isolated orchard where there would be but little danger of its extending to other localities. As soon as the infestation was discovered, the affected trees were sprayed with the lime-sulphur mixture. The orchard was again visited at the time when it was thought the first young would appear. It was found that a large proportion of the scales was destroyed, but the young were crawling on a number of the trees. The trees were then sprayed with kerosene emulsion, which killed the exposed young. It is proposed that a thorough treatment will be given the orchard and followed up until the infestation is entirely destroyed."

Specimens of this long dreaded orchard pest were received at the Station from Limerick, Maine, in August, 1909, for determination. Most of the scales on the several twigs submitted were dead but there were some live and healthy specimens. The infestation at Limerick is the first occurrence known in Maine. Any one finding scales on his trees resembling those shown in figures 11 and 12 should send specimens to the Department of Agriculture at Augusta or to the Experiment Station at Orono for identification. (Lot 794.)

Eriopeltis festucae (Cottony Grass Scale).

The white egg sacs of this insect on leaves of meadow grass are an annual occurrence and were plentiful in the vicinity of Orono this past season. Little complaint has been made for several years by owners of grass lands invaded by the cottony scale. (Lot 770.)

Typhlocyba comes (Grape leaf hopper).

This bug is reported from Calais, Maine, as being very destructive to the Virginia creeper, infesting almost all the vines of that section. The correspondent states that it has been prevalent there for a number of years and while the plant is not absolutely destroyed the growth is much checked, and the leaves become spotted, wither and fall.

The eggs are stuck to the lower surface of the leaves in June; from June to September the immature form, the nymph, a light yellowish green bug with yellow side stripes, works upon the leaves. The adults, about 1/8 inch in length, marked with yellow and red, beginning to appear in August, continue the work of destruction begun by the nymphs. Spraying in July with whale oil soap solution and the use of sticky screens have been recommended for the pest in vineyards. (Lot 790.)

Psylla floccosa Patch (Downy Psyllid of Alder).

Very common upon the Alder (*Alnus incana*) from early spring to late June, are fluffy, woolly masses, abundant on the under side of leaves. Fig. 17 represents such a characteristic mass. If the white fluff is removed, little yellow and green crab shaped objects are found beneath the protective mass which is secreted by wax glands similar in function to those of certain woolly plant lice and scale insects. About the last of June these insects acquire wings and shaking themselves free from the white secretion, take to flight. This species was described and figured in Canadian Entomologist, September, 1909. (Lots 727, 735, 740, 744.)

APHIDIDAE.

Plant lice found a favorable season and many species were noticed in the vicinity of Orono. Attention, however, was concentrated for the most part on those species of the Genus *Chermes* causing abnormal growths on spruce. Six species were studied, namely, *Chermes pinifoliae* Fitch, *Chermes abietis* Linn, *Chermes similis* Gillette, *Chermes floccus* Patch, *Chermes consolidatus* Patch, and *Chermes lariciatus* Patch. The three new species were very briefly described in Psyche for Decem-

ber, 1909. *Pinifoliae* and *abietis* were treated in an economic bulletin No. 171 of this Station and the six species are described and figured and the main points in their life histories given in Chermes of Maine Conifers, Bulletin 173 of this Station.

A woolly species, *Pemphigus venafuscus* Patch, on the stems of ash occurred in abundance in the vicinity of Orono. This species was described and figured in Entomological News, July, 1909.

The Canadian tick-trefoil is yearly visited by a plant louse causing leaf curl and twist. This was described as *Microparsus variabilis* new genus and new species in Entomological News, October, 1909.

Gall making aphids of the elm were abundant but as the group will be treated more fully in a separate publication it is not necessary to discuss them here.

Anaphothrips striata (Grass thrips).

Late in June Timothy grass showed the characteristic dry and bleached stems due to injury by the grass thrips. In some meadows considerable areas were rendered conspicuous in this way. (Lot 750.)

ORTHOPTERA.

(Grasshoppers, roaches and crickets.)

Grasshoppers caused enough damage during 1909 as during 1907 and 1908 to be classed as a plague. Orchards and garden crops suffered from the attacks of these ravenous insects. The species concerned, as far as ascertained, were the same as those mentioned in the Insect Notes for 1908.

DIPTERA (Flies).

Mycetophilidae (Fungus gnats).

A work on the fungus gnats of North America is now in the course of preparation, the first part of which appearing in Bulletin 172 of this Station. As it is the purpose to discuss in that paper in detail the habits of several species, it will only be

necessary here to state that certain forms are exceedingly common and some are known to be injurious to corn, potatoes, apples, mushrooms, and other forms of plant life.

Of the lower forms the larva of *Mycetobia* lives on decaying wood and has also been accused of attacking the sound roots of apple and peach trees, though it is very doubtful if they are able to cause serious injury here. Walsh, Riley, and Glover all agree as to the inoffensive character of the members of this genus. The *Sciophilinae* and *Mycetophilinae* are known to live upon decaying wood and also upon mushrooms. In the tenth report of the State Entomologist of New York, Lintner quotes a prominent mushroom grower as saying that the crowning evil of mushroom culture is the maggot of the fungus gnat. "By cutting open the mushroom you may see numerous worm holes in some of these, both in the caps and the stems, and no doubt can discover some of the maggots. They are tiny fellows with white body and black head, measuring about 1-5 of an inch in length. . . ." It may be stated in this connection that frequently associated with the maggots of the fungus gnats are larvae of *Phoridae,* also serious pests.

The *Sciarinae,* a subfamily of the fungus gnats and known to the Germans as Trauermücken (Mourning gnats), which also have been accused of damaging fungi by Doctors Smith, Felt, and others, are probably less frequently found in sound plants than in such as are already badly decayed, differing in this respect from those mentioned before. Professor Forbes, State Entomologist of Illinois, reports that they are occasionally injurious to seed corn. They are also known to feed upon potatoes affected by scab or rot, and in some instances appear to be the precursor of some form of scab. This form of scab should not be confused with the common potato scab (*Oospora scabies*). They are found in apples associated with the railroad worm (apple maggot) and in bulbs of tulips and peonies. Whether they are actually injurious to the roots of potted plants is not yet definitely known, though they are looked upon with suspicion by florists generally.

Mycetobia divergens Walker.

The larva of this species, living in decayed wood from an apple tree, was sent to us by a correspondent from Gardiner,

Maine. As the larva is not figured in Bulletin No. 172 some details will be figured and described here. The larva is white in color, 12 segmented, slender and legless. The head is yellowish brown, oblong, about twice as long as wide, the labrum has a rounded margin, setose ventrally. The mandibles are brown, margined with a number of teeth and with a toothed claw on the inner side (figs. 41, 42); the lateral comb of the epipharynx has 6 teeth (fig. 39); the labium has several smaller as well as two larger ones and its lateral margins are fringed with long hairs (fig. 38). The maxilla is shown in figure 40. There are a few scattered bristles on the head and two eye spots. The two main tracheal trunks end in the thoracic spiracles (fig. 43) on the center of the lateral margin of the first thoracic segment and extend to the apex of the twelfth abdominal segment; they are connected by a strong commissure at the anterior end of the second thoracic segment. The length of the full grown larva is about 1/4 of an inch.

The pupa is brown; tapering, with a few spines on thorax and abdomen projecting backward; length 1-6 of an inch.

Tipulidae (Crane flies).

Two crane flies from Maine may be noticed at this time as being of particular interest. The one, *Ctenophora apicata,* because of its rarity, and the other because of possible economic interest to potato and apple growers.

Ctenophora apicata.

Nine males and six females of this handsome crane fly were reared from larvae and pupae found in the decaying wood of an elm tree. They were collected at Orono, Maine, June 23, by Mr. William Woods. Though this species is not of economic importance still it may not be out of place to give here a brief description owing to its rarity. The male appears never to have been described.

The full grown larva is white, cylindrical, over 1 1/8 inches long. The head is black, well formed, oval, 3-64 of an inch in diameter and twice as long; apparently only the apical fourth can be exserted. The antennae are cylindrical with an apical papilla. On the dorsal surface of the head at some distance

back of each antenna is a slender, flexible spine. Here and there upon the body may be seen a minute bristle; at the caudal end are the two black spiracles, dorsad of which are 4 finger-like processes and ventrad are 2 conical protuberances.

The pupa is brown in color; ¾ to ⅞ of an inch in length. On the anterior part of the thorax on the dorsal surface are the breathing organs, slender, transversely striated, about 3-32 of an inch in length. Each intermediate abdominal segment has 8 pairs of sharply pointed conical protuberances, those on the posterior part of the venter on the middle line larger than those on the mid-dorsal line and much larger than those on the sides. The last segment has but 4 and the next to the last 8 such projections. On the anterior segments some may be much reduced or even wanting.

The adults show considerable variation in coloring, there being a light and dark form of each sex. Between these forms are several specimens showing more or less intergradation.

Male. Dark form. Shining black; the tips of the basal antennal joints, the tips of the antennal branches, of which there are four rows, knob of halteres and the palpi more or less fuscous; the fore legs, the tibiae and tarsi of the middle legs together with the middle section of the femora, the hind tibiae and tarsi, and the dorsal portion of the collar are yellow; wings deep blackish brown, except for the hyaline spots on the veins bounding proximally and distally the discal cell and one at the stigma (fig. 14).

Pale form. Shining reddish yellow excepting an occipital triangle, the humeri, base of metanotum, thoracic and pleural sutures, narrow lateral and hind margins of the more posterior segments, dorsal spot on the first segment, and forceps themselves, tibial spurs and apical fourth of middle and hind femora are black. Wings yellowish, subfuscous apically.

Female. Dark form. Like the male but the basal antennal joints, the collar and the whole of the middle femora are black; the lateral posterior margin of the fifth segment of the abdomen and the tip of the ovipositor are yellow.

Pale form as described by Osten Sacken. (Lot 743.)

Trichocera regelationis.

In Insect Notes for 1907 (Bulletin No. 148, Me. Agric. Expt. Station, p. 278) mention was made of the occurrence of this species breeding in potatoes; the slender maggots having been found in a lot of potatoes that froze the preceding fall and were soft and rotting the following May. Whether this species would develop in sound potatoes was not ascertained. In a letter dated May 6, 1907, from a correspondent in Patten, we read: ". . . This maggot goes only under the skin; not doing much damage to the tuber. . . . Sometimes they will eat turnips, especially sweet ones, so that it spoils them. Carrots, parsnips, onions, and in fact everything that has a tender root." From the context of the remaining portion of the letter it is evident that our correspondent has confused the maggots of several species of flies, among them *Sciara, Pegomyia,* and perhaps others. For this reason a brief description of the maggot will be given here with the hope that the reader may keep a lookout for similar larvae and submit them to the Experiment Station for identification. This species has also been recorded as being injurious to apples.

The maggot is a slender, legless, whitish creature, over ⅜ of an inch in length when full grown. Its head is brown, narrower than the first body segment, but quite distinct wholly exserted, and apparently not retractile, differing in this respect from the majority of crane fly larvae. The body segments, 12 in number, are very indistinctly marked, the transverse folds on each segment being nearly as distinct as the sutures themselves. The surface of the body is rather thickly covered with fine pale hairs more or less erect and mingled with these are some small bristles not markedly differentiated from the hairs. The mouth parts resemble somewhat those of *Rhyphus*. The labrum, epipharynx, mandible, hypopharynx, maxilla and labium, are as shown in the figures (figs. 52-55). The lateral comb of the epipharynx (ep. c. fig. 53) has blunt, rounded teeth. On the ventral side of the last segment is the anal plate (fig. 51) perforated by a transverse slit at the center. The anterior spiracles or breathing organs are small, rounded openings situated on the dorsal surface of the first thoracic segment; the

posterior spiracles (fig. 57) on the last segment open dorsally and are each covered by a hairy flap (fig. 56 fl.). The body ends in two fleshy lobes (fig. 56).

The pupa is over ¼ inch long with small, papilliform, thoracic spiracles; the caudal end narrower, its apex with 2 slender pointed lobes. The slender, long-legged, mosquito-like adult may readily be distinguished from other crane flies by the presence of a very short and much curved vein near the base of the wing posteriorly and by other points in venation shown in figure 13. These flies are not uncommonly found even in late fall and winter hovering over a small brook or spring or over the snow. (Lot 188.)

RHYPHIDAE (False Crane flies).

Rhyphus punctatus.

This fly though probably of no great economic importance may not be without interest because of the resemblance the larvae bear to those of *Trichocera* described above and because of the resemblance the adults bear to the malarial mosquitoes for which they are occasionally mistaken by the non-entomologist. The larvae of the members of this family live in decaying vegetable matter. The specimens from which the following description was drawn were found in cow dung.

The larva is a slender, cylindrical, legless maggot over ⅜ of an inch in length with 12 distinct body segments which are broadly marked with mottled brownish or purplish bands leaving only the sutures white. The twelfth segment is shorter and smaller than the others, less sharply separated from the eleventh, and ends in 2 rounded fleshy lobes margined with setae (fig. 48). Ventrally there is an oval anal plate perforated by a transverse slit near the posterior margin (fig. 49). Dorsally are the 2 crescent shaped spiracles (fig. 48 sp.) which are bounded laterally though not covered by flaps; between them is a transverse fold margined with setae. The thoracic spiracles (fig. 47) are small and have but 3 more or less oval apertures. The antennae are very minute, two segmented and papilla-like. The mandible (fig. 44) is apically densely covered with two tufts of hair, one on each side, and which so overhang the tip that

its structure cannot be described. On the inner side of the mandible is a spur with several teeth. The lateral comb of the epipharynx (fig. 46) is provided with several blunt teeth. The labrum is oval and margined with setae, the labium (fig. 45 lm) is deeply bifid.

The adult which is frequently seen upon the windows of dwellings resembles somewhat some malarial mosquitoes in possessing spotted wings—but it may readily be distinguished from the mosquito by its short, blunt proboscis.

Culicidae (Mosquitoes).

These pests are with us the greater part of the year, though troublesome mainly in spring and summer. In recent years they have been much studied because of their relation to malaria and other diseases. In Insect Notes for 1906 (Bul. No. 134, Me. Agr. Expt. Station) is given a short list of Maine mosquitoes, among them two species of Anopheles, one of which is known to be a malaria carrier. *Anopheles* may readily be distinguished from the others by the spotted wings, by the form of the mouth parts which consist of 3 slender processes, and by the habit of standing when at rest upon a wall with the body inclined at an angle with the vertical. Though no special effort was made to collect them, two rather rare non-malarial mosquitoes were taken the past season, *Culex atropalpus* and *saxatilis*. The former was bred from larvae taken in the rock pools from the Stillwater branch of the Penobscot river, September 22. Of the latter, specimens were captured in the basement of a dwelling in Orono on December 17 and 21.

As all mosquitoes breed in water, the covering of rain water barrels, filling in of small pools and draining of swamps will do much toward reducing the number of these insects.

Muscidae (Flies).

Epochra canadensis (Currant fruit fly).

In a letter dated July 16 a correspondent from Westbrook reports that one-third of his currant crop was ruined by a maggot which lives in the fruit. It is the larva of the currant fly,

a small white maggot about 1-3 of an inch in length. The adult is a small two-winged fly with banded wings. It is described in Bulletin No. 35 Me. Agric. Expt. Station. (Lot 766.)

Drosophila busckii.

This insect belongs to the same genus as the little yellow flies commonly known as Pomace or fruit flies. It has been bred several times from larva found in potato affected by rot. Apparently only the potatoes with broken skin were attacked, though there were a number of decayed tubers. From this it seems evident that the flies were not responsible in starting the rot. As may be expected this fly in all its stages greatly resembles *Drosophila ampelophila,* the common Pomace fly, described by Professor Comstock in the Report of the Entomologist, Department of Agriculture for '81-'82.

The egg though similar in shape differs from that of *D. ampelophila* in having 4 slender and pointed filaments (not blunt) near the micropyle. The larva is elongate oval, about 5-16 of an inch in length when full grown; the head end more slender and pointed; the posterior end of the body broadest. The antennae are minute tubercles placed on the dorsal surface of the first segment; the 2 jaw hooks are black in color and each provided with 4 slender teeth of which the third from the base is smallest (fig. 50). Fringing the mouth are a number of minute colorless, recurved hooks only distinctly visible in profile. The cephalic spiracles each consist of about 12 tracheal tubes of varying lengths, slightly hooked at the end. These tubes may be extended or retracted within a cylinder which is somewhat longer than wide. The body is covered, though not densely, with erect setulae, and each segment is provided with about 8 spinose protuberances, fewer and longer on the last 2 segments where they nearly equal the caudal spiracle in length. The latter consists of 2 coalesced tubes. The pupa, which is about ⅛ of an inch long, resembles the larvae in having the body sparsely covered with setulae, spinose protuberances, and a caudal spiracle of 2 coalesced tubes. At the head end there is a large concavity, covered by a plate which comes off when the adult emerges. To this plate are attached the thoracic spiracles, cylindrical processes each terminating in 12 tracheal

tubes of varying length. The adult is a little yellow fly about $\frac{1}{8}$ of an inch long with striped thorax and abdomen with black markings. (Lot 847.)

Pegomyia sp.? (Cabbage maggots).

A correspondent from Bowdoinham, Maine, in a letter dated July 1, reports the destruction of 25,000 cauliflower plants by maggots. As no specimens were received the species was not determined, though it may have been *Pegomyia brassicae* or some allied form.

Musca domestica (House or typhoid fly).

The ever present and pestiferous house fly because of its filthy habits continues to be a serious menace to the health of the community. As they breed in stable manure every effort should be made to reduce their number by the removal of this refuse from the vicinity of dwellings. Foods of all kinds should be carefully protected from them. Milk should be handled with great care to prevent flies from contaminating it, as it is a most excellent medium for the development of the typhoid bacilli as well as of the bacilli of some other intestinal troubles to which young children are highly susceptible. Upon this subject much has been said and written, but too much stress cannot be laid upon a matter of such vital importance.

Frontina archippivora (A parasitic fly).

A specimen of the chrysalis of the monarch butterfly (*Anosia plexippus*) sent from South Berwick was found to be parasitized by the above named fly. The pupal stage of the parasite was passed outside of the butterfly chrysalis. The flies emerged August 28. (Lot 789.)

COLEOPTERA.
(Beetles.)

Carpophilus hemipterus.

Many of these beetles and their larvae and pupae were found in a box of California dried peaches sent to the Station for examination from a storage house in Portland. The beetle (fig. 15) which is about 1/8 of an inch in length may readily be recognized by its short wing covers which are not produced over the last 2 abdominal segments. The insect is mainly dark brown in color; the legs, the posterior half and a spot near the lateral anterior margin of each wing cover, are yellow. The legs are rather stout, the tibiae are somewhat broadened, and the antennae are clubbed. Both larvae and adults feed in decaying and fermenting sap, pomace and fruit, particularly improperly cured dried figs, peaches, apples and the like, and are often associated with mites and the larvae of Pomace Flies (*Drosophila*). The insect is very widely distributed, almost cosmopolitan, and once established in a fruit packing house may prove a serious pest.

The larva or grub is a slender flattened creature about 1-5 of an inch in length, white in color with a brownish head and 3 pairs of legs. The mouth parts are as shown in figs. 20-22. There is a pair of thoracic spiracles on the second segment, and 8 pairs of abdominal spiracles, none on the last segment. Upon the body are a few scattered setae; on the dorsal surface of the last segment (fig. 23) is a pair of stout pointed tubercles, a stouter pair at the apex and a smaller one at the base of each of the latter. The pupa is of the simple, unprotected type, each abdominal segment has about 4 strong setose spines, largest posteriorly.

The destruction of all infested fruit by burning, and thorough fumigation of the warehouse by hydrocyanic gas are the only remedies which can be suggested for the destruction of this pest. (Lot 843.)

Euphoria inda (Bumble flower beetles).

Large beetles (fig. 16) about 5/8 of an inch in length, have been reported to the Station several times this season eating

apples in storage. As a single individual does not always confine its attention to one apple, a few beetles may sometimes injure a large number by biting into them. Harris records a similar habit regarding peaches. The head and thorax of this beetle are dark reddish brown, or almost black, thickly covered with short yellowish hairs, the wing cases are light yellowish brown mottled with irregular black dots. The under side of the insect is very hairy. As this insect is quite conspicuous it may be controled by hand picking. (Lot 826.)

Conotrachelus nenuphar (Plum curculio).*

At Lisbon, Maine, this insect has nearly ruined a crop of plums, while the apples from orchards in many parts of the State are reported as being commonly and generally infested with this pest. (Lots 747, 757.)

Elateridae (Wire worms).*

A farmer from Lagrange says: ". . . these threaten to ruin my potatoes. Every one raising potatoes in this vicinity has the same complaint. We did not see anything of them on this farm last year but one of my neighbors had them in his potatoes. . . ." Deep plowing and harrowing in the fall to expose the pupa and beetle, as a preventive measure, are most highly recommended. (Lot 763.)

Scolytid Beetles in Pine Cones.

Some specimens of cones from the White Pine, brought to us by Doctor Chrysler of the University of Maine, collected June 15 in Orono, were found to be mined by a Scolytid beetle. Every cone on the branch brought in was affected. On opening a cone, the whole structure was found to be mined through, two or three beetles being inside; and a gummy brown mass at or near the base giving evidence of the work within. The beetles made an exit at or near the apex. The cones were those which started to grow last year. Professor J. M. Swaine, of Macdonald College, Canada, who has made a special study of this family of beetles, to whom specimens were sent, determined them as *Pityophthorus coniperda*. (Lot 734.)

* A descriptive economic circular is available to applicants.

Xyleborus dispar (Shot borer).

In a letter dated June 3, from a correspondent in West Tremont, Maine, the complaint is made that this beetle is killing the young apple trees. This beetle is a native species and attacks both hard and soft wood trees as well as the apple trees. The young larvae bore into the wood, making deep channels which in the small twigs interfere with the circulation of the sap, and the twigs wither, giving the appearance of blight. The beetle is less than one-eighth of an inch in length, dark brown or nearly black in color, with legs and antennae rusty red. They leave their burrows in July and deposit eggs before August, according to Harvey. It is a difficult insect to exterminate, especially in orchards in the vicinity of forest trees. Cutting out of diseased limbs and burning is the most satisfactory treatment. Lot 730.

Monohammus scutellatus (Pine borer).

Beetles of this species were found quite abundantly, June 30, in Orono, upon the larch. On many of the trees the young twigs appeared as if the bark had been chewed off. In Insect Notes for 1908 (Me. Agr. Exp. Station Bulletin No. 162) there is a record of this species destroying pine needles. The beetle is about 3/4 of an inch in length with antennae double the length of the body in the male. It is shining black, its wing-covers having small patches of short hairs here and there resembling spots of white mold, their surface rough from coarse confluent punctures and the thorax similarly punctured across its middle, its base and apex with irregular transverse wrinkles, and its sides with a conical spine, which is not clothed with hairs, and the scutellum coated over with white hairs. The large white grub bores in the wood. The beetle is rather common in Maine. If anyone should see this insect feeding upon leaves or twigs of any tree, he will confer a favor upon us if he send in a record of his observations. Lot 780.

HYMENOPTERA.

(Four-winged flies, etc.)

Lophyrus abietis (Spruce saw-fly).

This saw fly, noted last year in Bulletin 162, was again very abundant the past season on fir and spruce. From Birch Island, near the mouth of Damariscotta River, a correspondent writes August 3: ". . . I find the saw fly busily at work, and the devastation in the country around is appalling. Here it is now at work on the red spruce and I have a number of trees entirely eaten off, and the caterpillars lie as thick as leaves. . . ." In woodland trees artificial remedial measures are probably impractical and there the pest can only be left to such natural control as climatic conditions, fungous disease, or the attacks of predaceous or parasitic insects. For ornamental trees we may resort to spraying as soon as the larvae are in evidence.

From a large number of cocoons collected, about an equal number of males and females emerged. A few parasites, *Pimpla* sp. and others, were also reared from the cocoons. (Lot 791.)

Nematus erichsonii (Larch saw fly).

A report from Gardiner, Maine, dated July 14, states that "a small grove of larch near the house stripped almost as bare as winter." This is the insect which caused such devastation to the larches in this State a number of years ago, that in some sections they were wholly exterminated.

As with the Spruce saw fly we must place our chief reliance upon the natural enemies, parasites and predaceous bugs and climatic conditions, to hold this pest in check upon woodland trees. Spraying where feasible will control them. (Lot 765.)

EXPLANATION OF PLATES.

PLATE

10-12 San Jose or Pernicious scale (*Aspidiotus perniciosus*). Page 28.

10 Active young, greatly enlarged (After Felt).

11 Young scale in black stage, greatly enlarged (After Felt).

12 Group of adult scales, enlarged (After Felt).

13 Wing of Crane fly (*Trichocera regalationis*). Page 34.

14 Wing of Crane fly (*Ctenophora apicata*). Page 32.

15 Sap beetle (*Carpophilus hemipterus*), greatly enlarged. Page 39.

16 Bumble flower beetle (*Euphoria inda*). Twice natural size. Page 39.

PLATE

17 Leaf of the Alder showing secretion of Downy Psyllid. Page 29.

18 Apple leaf folded by apple leaf sewer. Page 26.

19 Birch leaf showing work of *Bucculatrix canadensisella*. Page 24.

PLATE

All details are of the larvae unless otherwise noted. an = antenna; ep = epipharynx; ep. c = comb of epipharynx; fl = flap covering spiracle; hyp = hypopharynx; lm = labium; lr = labrum; mn = mandible; mx = maxilla; sp = spiracle.

Carpophilus hemipterus. Page 39.

20 Mouth parts; Dorsal aspect. x 63.

21 Labium and maxilla; Ventral aspect. x 63.

22 Labium; Ventral aspect. x 175.

23 Caudal end; Dorsal aspect. x 40.

Achatodes zeae. Page 23.

24 Mouth parts; Dorsal aspect. x 20.

25 Maxilla. x 20.

26 Anal plate; Dorsal aspect. x 10.

27 Apex of abdomen of pupa. x 40.

Ancylis (Phoxopterus) nubeculana. Page 26.

28 Mandible. x 80.
29 Labrum; Dorsal aspect. x 80.
30 Antenna. x 80.
31 Labium and first maxilla. x 80.
32 Anal fork. x 175.

Bucculatrix canadensisella. Page 24.

33 Labium and first maxilla. x 175.
34 Mandible. x 175.
35 Labrum; Dorsal aspect. x 175.
36 Abdominal leg. x 175.
37 Claw of anal leg. x 350.

Mycetobia divergens. Page 31.

38 Labrum; Ventral aspect. x 350.
39 Lateral comb of epipharynx. x 350.
40 Maxilla; Ventral aspect. x 175.
41 Mandible; Lateral aspect. x 175.
42 Mandible; Mesal aspect. x 175.
43 Thoracic spiracle. x 350.

Rhyphus punctatus. Page 35.

44 Mandible; Lateral aspect. x 350.
45 Labium, maxilla and hypopharynx; Ventral aspect. x 63.
46 Lateral comb of epipharynx. x 350.
47 Thoracic spiracle. x 350.
48 Caudal end, dorsal. x 80.
49 Anal plate. x 25.

Drosophila busckii. Page 37.

50 Mandibular hook. x 175.

Trichocera regelationis. Page 34.

51 Anal plate. x 175.
52 Mandible; Mesal aspect. x 175.
53 Labrum; Ventral aspect. x 175.
54 Mandible; Lateral aspect. x 175.
55 Lower mouth parts; Ventral aspect. x 75.
56 Caudal end; Dorsal aspect. x 40.
57 Caudal spiracle. x 80.

BULLETIN No. 178.

A NEW SPECIES OF ENDOMYCES FROM DECAYING APPLE.

CHARLES E. LEWIS.

In October 1908, the fungus which is described in this paper was discovered by the writer in connection with a study of apple decay fungi at this Station. In examining material from an apple which showed a small injured place which was overgrown by fungus mycelium and had a rather dry appearance, the spores of several fungi including species of *Alternaria, Cladosporium,* and *Fusarium* were found. Associated with these were a large number of almost spherical brown bodies which were for the most part 11-14 microns in diameter, each of which was found to contain 4 spores. Dilution plate cultures were made, using prune agar as a culture medium. Eight fungi developed in these plates and among them was one which produced conidia in very much the same manner which has been described by Brefeld (1) for *Ascoidea rubescens* Brefeld. The conidia were formed in such large numbers that they became piled up on the agar to such an extent as to give a powdery appearance. There was almost no development of aerial mycelium.

When the cultures were examined, 10 days after they were made, it was found that a large number of small bodies resembling the spore sacs or asci of an *Endomyces* had developed. These sacs were borne on short branches of the hyphae as shown in Figures 60, 61, and 65. Some of the sacs had already formed spores and in each case, so far as determined at that time, 4 spores were found. Later study has shown that there are usually a considerable number of the bodies which do not form spores and that there may be occasionally an ascus which forms only 2 spores. Cases in which only 2 spores are formed are very exceptional and are very rarely seen. No case has ever been observed in which more than 4 spores were formed. When the ascospores are mature they are brown in color. They vary in size according to the size of the ascus but in asci which

measure 11 microns in diameter the spores are about 4 x 5.5 microns. The ascospore has a thick wall with usually a number of thickened places on the wall. The asci or sacs which do not produce spores vary in size and appearance. In some cases they are of normal size and appear hyaline and seem to be lacking in contents. In other cases they are smaller, being 7-8 microns in diameter and contain a number of refractive bodies which are probably food material. Some of the smaller sacs in which no spores develop bear some resemblance to chlamydospores but they do not germinate when sown in hanging drop cultures.

The fact that the conidia and the spore sacs belong to the same fungus was determined by finding cases in which the branch bearing conidia was attached to the same hypha which was producing spore sacs. It was also determined by the fact that colonies which developed from a single spore began to produce conidia in 1 to 3 days and later the spore sacs began to develop so that in 6 to 10 days large numbers were found.

Since this fungus was isolated from a decaying apple, it seemed desirable to determine whether it could cause decay of apples upon inoculation. A number of apples were inoculated November 4, 1908, from pure cultures. A slow decay took place and after 10 days the decayed regions at the points of inoculation were each about 1.5 cm. in diameter. Some of the decayed tissue was removed from one of the apples and was teased out and examined. Large numbers of the spore sacs were found occupying the spaces between the cells. Plate cultures were made by taking out some of the decaying tissue from points inside one of the decaying apples with a sterilized scalpel and transferring to petri dishes containing prune agar. Pure cultures of the fungus with which the apple was inoculated were secured in each case showing that this fungus was responsible for the decay. One month after the time of inoculation, the fungus was reisolated in pure culture from an apple which was about one-half decayed. In the summer and fall of 1909, inoculations were made to determine whether this fungus could attack green apples and it was found that while in some cases it grew to a slight extent in the injured tissue at the point of inoculation in no case did it cause decay of unripe apples. It does not seem probable that this fungus will become of much importance as a cause of apple decay since it causes only a slow decay of ripe fruit.

The chief interest in its study lies in the fact that it belongs to a family of fungi no representative of which has been reported from America so far as the writer is able to determine. The character of producing spores in sacs or asci on short branches of the mycelium places it in the family *Endomycetaceae* and the fact that the 4 spored ascus is formed from a single branch and not from a fusion of two branches places it in the genus *Endomyces,* according to the classification of Schröter (12). The fungus under consideraticn, however, differs from the described species of *Endomyces* in certain morphological and cultural characters.

Endomyces decipiens (Tulasne) Rees, which ocurs as a parasite on *Armillaria mellea* Vahl, has asci which are 12-13 x 17 microns. This species produces chlamydospores which are 10-12 x 15-17 microns, and the mycelium breaks down to form oidia. *Endomyces Magnusii* Ludwig was described by Ludwig and was later studied by both Brefeld (2) and Hanson (6). It occurs in fermenting sap of the oak in Germany. The cells of the mycelium of this species separate very readily to form oidia. The asci do not develop in culture under ordinary conditions but Brefeld secured them by growing the fungus so that the mycelium was deeply buried in gelatin. The asci are large, being 25 x 40-45 microns. *Endomyces scytonematum* Zukal produces asci which are 17-18 x 25-26 microns. Each ascus contains 8 spores. *Endomyces meliolincola* Rehm has asci which are 45 microns in diameter. *Endomyces coprophilus* Massee and Salm. has asci which are 18-25 x 20-30 microns and contain 4-8 spores.

Endomyces parasiticus Fayod occurs as a parasite on *Tricholoma rutilans.* The hyphae are 2-3 microns in diameter, the asci are somewhat pear shaped, are 12 microns in length and 6-7 microns across at the broad end. This species differs from *Endomyces decipiens* and *Endomyces Magnusii* in producing conidia which are cut off from the end of a slender conidiophore and in the fact that the mycelium dces n t break down to form oidia.

The fungus which was isolated from apple, when grown upon a number of culture media, produces hyaline one-celled conidia after the manner shown in Fig. 66. The conidia vary somewhat in size, being 3-3.5 x 6-10 microns but for the most part mature conidia are about 3 x 8 microns. The hyphae vary in thickness from 3 to 6 microns. The asci are as a rule almost spherical,

are 11-14 microns in diameter and are borne on branches which vary considerably in length. Some asci are found which are less than 11 microns in diameter and some are found which are not spherical being somewhat pear shaped. In some cases also rather abnormal development of the spore sacs takes place as shown in Fig. 70, but by far the most common method of production of asci is for a number of single asci to develop on short branches from a hypha, as shown in Figures 60, 61, 62 and 65.

In order to determine the extent of variation in growth of the fungus and the effect upon its reproduction, it has been grown upon a rather large number of culture media.

Cultural Characters.

When the conidia are placed in a hanging drop of prune decoction, potato broth, or beef extract broth plus 2 per cent dextrose, at room temperature, they germinate readily. The conidia become considerably swollen and within 4-5 hours a number of them will begin to put out germ tubes. As a rule the conidium puts out only one germ tube but in some cases two are produced from opposite sides of the spore. In some cases, even in the hanging drop, the germ tube may grow out to form a branched mycelium on which short conidiophores bearing the conidia are borne as shown in Fig. 66. In other cases, the germ tube may grow out and begin to bud off conidia from the end within 16-18 hours. Some conidia are formed in very irregular ways as shown in Fig. 67. The conidia did not germinate in hanging drops of neutral beef extract broth.

The ascospores germinate, in some cases at least, while still in the ascus. Material from a culture 3 weeks old growing on bean agar and in which there were a large number of asci which contained spores was thoroughly washed to remove conidia and then teased apart and enough material to contain several asci in each case was placed in each of 5 hanging drops of prune decotion. After 16 hours, examination showed that in a number of asci one or more of the spores had germinated. Here, as in the case of germinating conidia, some of the germ tubes grow to form a branched mycelium and in some other cases conidia are formed on the end of the germ tube within 18 to 24 hours after the spores are sown as shown in Figure 69.

The characters of the growth upon a number of culture media will be given the temperature being about 20° C. in each case. The notes are based on observations of 2 or more tubes in every case, and with the agars on plate cultures as well.

Prune agar. When conidia are sown in plates of prune agar they germinate readily and by the end of 48 hours a much branched mycelium is formed with numerous conidiophores which bear large numbers of conidia. For good growth the medium must be acid. Prune agar was made alkaline to —2.5 Fuller's scale with NaOH, neutral, and acid to +2.5, +10, and +20 with HCl. There was no growth in the alkaline medium and very little in the neutral while the growth in the acid medium was good, that in +10 and +20 being equally good. The relation of the growth of the fungus to acids will be discussed later in this paper.

Prune decoction + 12. The growth in a decoction made by cooking 6 good sized prunes in 1000 c. c. of distilled water is very good. The mycelium develops rapidly in the bottom of the tube and after about 48 hours a film has developed over the surface of the liquid. The spore sacs or asci develop well in this medium and many are found which have formed spores at the end of 10 days. There is a good development of the mycelium and there is no tendency to break down to form oidia in the liquid medium as is the case with *Endomyces Magnusii.*

Potato agar + 6. At 42 hours conidia had been produced in large numbers. After 5 days a few developing spore sacs were observed and when the cultures were 9 days old large numbers of spore sacs were seen, in some of which the spores had developed.

Potato broth. In neutral or alkaline potato broth there was no growth but when a drop of lactic acid was added to each tube before inoculation the fungus grew readily and at about the same rate as in prune decoction. Large numbers of asci were found 9 days after the tubes were inoculated.

Bean agar. The growth here is practically the same as on potato agar.

Bean pods. In bean pod tubes the growth is mostly confined to the liquid and to that part of the pod just above the liquid.

Vegetable plugs. On sterilized potato, beet, turnip, and car-

rot cylinders in tubes the growth is good. In 40 hours the entire slant of the plug is covered by the fungus and conidia are being formed. The conidia are formed in such abundance as to become piled up in considerable masses giving a wet slimy appearance. After conidia are formed, they germinate in some cases, producing short germ tubes on which conidia are formed in the irregular manner described as occurring in hanging drops. The vegetable plugs seem to be much more favorable to the development of conidia than asci, as the asci are not found in very large numbers.

Apple wood. On sterilized apple twigs in tubes the growth is good. There is considerable mycelium in the liquid and a thick slimy covering on the upper ends of the pieces of wood at the end of one week. Both conidia and asci are produced in large numbers.

Beef extract agar. It has been noted above that the spores did not germinate in hanging drops of neutral beef extract broth. On neutral beef extract agar no growth took place but when the agar was made acid to +20 with hydrochloric, lactic, or acetic acid the fungus grew to a slight extent.

Beef extract gelatin. On this gelatin, when made acid with lactic acid, the growth is about the same as on beef extract agar. No liquefaction of gelatin but there was very little growth.

Beef extract gelatin + dextrose. The fungus grows very well on this medium and causes some liquefaction of the gelatin at the end of one week. After one month the gelatin in the tubes was liquefied to a depth of 1.5 cm.

Sugar agars. Agars made by adding 1 per cent of dextrose, saccharose, lactose or mannite to beef extract agar. When these sugar agars were neutral, no growth took place, but when they were made acid the fungus grew on all of them. The growth on lactose and mannite is poor but on dextrose and saccharose the growth is good. The fungus produces a rather thick, whitish mass composed largely of conidia but does not form many asci.

Sugar broths. The same 4 sugars which were used in agars were also added to beef extract broth. One, 2, 5 and 10 per cent of dextrose were tried and gave about equally good growth. With the other sugars 2 per cent was added to the broth in each case. These broths were made acid to +15 with hydro-

chloric acid. The relative growth with the sugar broths is the same as with the sugar agars. Dextrose and saccharose give much better growth than lactose and mannite. Few asci develop in these broths in comparison with the number that develop on some other media.

Dunham's solution. Small amount of growth in this medium and in the same medium plus lactic acid.

Dunham's solution + sugars. When the 4 sugars used with agar and beef broth were added to Dunham's solution which had been made acid with lactic acid they gave about the same relative growth as with the agars and beef broth.

Glycerine agar. Five per cent glycerine added to beef extract agar and made acid with lactic acid. The growth is thick and somewhat wrinkled when the cultures are 5 days old. When a small piece was removed with a needle, it was found to be rather gelatinous and hard to tease apart. When examined with the microscope this material showed a very great number of asci. This medium seemed to be more favorable to development of asci than any of the other media which were used.

Rice. The fungus does not grow very well on rice sterilized in distilled water but it forms a considerable number of asci.

Corn. Enough crushed yellow dent corn was placed in each tube so that when distilled water was added to soak it up it made about 10 c. c. The fungus grew very well on this medium and produced both conidia and asci.

Milk. Fresh milk from which the cream had been separated was sterilized in the Arnold sterilizer. The fungus did not grow well in this medium but when a drop of lactic acid was added to each tube before inoculation, good growth took place.

Relation of Growth to Acids.

It has already been noted in several places in connection with the growth on various media that this fungus requires an acid medium for its growth. A considerable amount of work has been done and data obtained on this subject. The fungus has been grown in liquid media to which definite amounts of different acids have been added. For the most part, 2 per cent. dextrose broth has been used because it was found that this made a favorable medium. An attempt has been made to determine

three things: (1) The extent to which the growth of the fungus in a medium changes the acidity of that medium; (2) the relative effect of different acids on growth; (3) the amount of a given acid which it is necessary to add to prevent growth.

Three inorganic acids,—hydrochloric, sulphuric and nitric,—and 7 organic acids,—lactic, acetic, citric, tartaric, oxalic, malic, and formic,—have been used. Normal solutions or solutions of twice the normal strength in some cases have been used in making up the medium to a given acidity. The acid was added to the dextrose broth in most cases before sterilizing but in the case of some of the volatile acids, the acid was added cold after the tubes had been sterilized and the tubes were then incubated for 3 days to prove sterility before inoculation. The cultures were made in test tubes each containing 10 c. c. of the culture medium. The acidity of the media is expressed in each case in terms of Fuller's scale.

To determine what change takes place in the acidity of culture media due to the growth of the fungus, a large number of determinations were made. In a considerable number of cases uninoculated tubes were kept as checks and titrated on the same day as the inoculated ones. In determining the acidity, the entire contents of the tube were poured into a porcelain dish and the tube was rinsed with part of the 50 c. c. of distilled water which was added. The dish was heated over a flame until the contents boiled for about one minute and then the titration was made.

It was found that in the case of 2 per cent. lactose broth or of 2 per cent. mannite broth neither of which is a favorable medium for the growth of the fungus, there was little or no change in the acidity after 18 days. In 5 per cent glycerine broth, the acidity increased from +12 to +18 at the end of 11 days. In 2 per cent dextrose broth, the increase in acidity varied from one to two per cent as shown in the table given below. In 5 per cent and in 10 per cent dextrose broth the acidity increased from +20 to +53 in the first and from +15 to +52 in the second at the end of three weeks. The table which follows shows that the acidity of the two per cent dextrose broth in which the fungus had grown for 2 or 3 weeks did not change to any extent by allowing the fungus to continue its growth for 2 weeks longer.

Acid used.	Acidity.	Inoculated.	Titrated.	Acidity.	Titrated.	Acidity
Hydrochloric	+10	March 20, 1909	April 12, 1909	+27.5		
"	+20	" 26, 1909	" 13, 1909	+39	April 27, 1909	+40
"	+30	" 26, 1909	" 13, 1909	+51	" 27, 1909	+48
"	+40	" 26, 1909	" 13, 1909	+50	" 27, 1909	+55
Lactic	+20	" 26, 1909			" 27, 1909	+41
"	+30	" 26, 1909	" 12, 1909	+49	" 27, 1909	
"	+40	" 26, 1909	"		" 27, 1909	+58
"	+60	" 26, 1909	" 12, 1909	+78	" 27, 1909	+77
"	+80	" 26, 1909	" 12, 1909	+95	" 27, 1909	+95
"	+90	" 26, 1909	" 26, 1909	+100	" 27, 1909	+100
"	+100	" 26, 1909	" 26, 1909	+112	" 27, 1909	+110
"	+120	" 29, 1909			" 27, 1909	+145
"	+150	" 29, 1909			" 27, 1909	+180
"	+220	" 29, 1909			" 27, 1909	+245
"	+280	" 29, 1909			" 27, 1909	+311

There is considerable difference in the amount of different acids which can be added to 2 per cent dextrose broth before the growth of the fungus is checked or entirely prevented. With hydrochloric, sulphuric and nitric acids there is good growth up to and including +60 but no growth at +80. Of the organic acids used, it requires a smaller amount of formic acid than of any of the others to prevent growth. There was fairly good growth at +20 and at +30, very little at +40 and none at +50. Malic, lactic, citric, and tartaric acids give good growth to high acidities. Very little difference can be noted with these 4 acids up to and including +300. Malic acid was only tested to +350 but gave good growth at that acidity. Lactic acid gives a little poorer growth at +350 than at +300, at +400 there is very little growth and at +450 it can scarcely be detected. Citric acid gave good growth up to +500 and was not tested further. Tartaric acid gives good growth up to +200, above +200 growth takes place slowly but there is a small amount of growth up to and including +600. With oxalic and acetic acids the growth increases slowly in comparison with that in citric acid for example. The limits of growth with oxalic acid is between +100 and +150. With acetic acid there is very little growth at +200 and none at +250.

Fermentation Tubes.

The *Endomyces* from apple has been grown in fermentation tubes which were filled with 2 per cent dextrose, saccharose, lactose, and mannite broths, and with 5 per cent glycerine broth. In dextrose, saccharose, and glycerine broths the fungus grew well in the open ends of the tubes but did not grow in the closed ends. In lactose and mannite broths, the growth was poor and was confined to the open ends of the tubes. No gas was produced in any of these fermentation tubes.

Relation of Temperature to Growth.

The growth of the fungus on a number of culture media at 20 degrees C. has been given under the head of cultural characters. In order to determine the effect of lower temperatures, 2 tubes each of prune decoction, bean agar, potato agar, potato, beet, carrot and turnip cylinders in each case were inoculated and kept at temperatures of 15°-16° C., 12°-13° C., 8° C. and at 5° C. At 15°-16° C. and at 12°-13° C., there was a slow growth but not so good in either case as at 20° C. At 8° C. and at 5° C., there was no growth which could be noted at the end of one week while in check tubes at 20° C., the fungus had spread over the entire surface of the slants. When the tubes which had been kept at 5° C., and at 8° C. were placed at a temperature of 20° C. growth took place readily.

Thermal Death Point.

Cultures of the fungus two days old in thin walled test tubes each containing 10 c. c. of 2 per cent dextrose broth made acid to +10 were used. A method of heating the cultures very similar to that described by Smith (14) was used. Tubes were heated for 10 minutes at each degree from 46° C. to 53° C. Transfers were made to other tubes of 2 per cent dextrose broth. There was good growth from all tubes up to 50° C. At 51° C. and at 52° C., the growth came up very slowly and at first it seemed that the thermal death point was between 50° C. and 51° C. but since growth took place at 51° C. and at 52° C. after a few days and no growth took place from tubes at 53° C. it seems that some place between 52° C. and 53° C. should be regarded at the thermal death point.

Growth from Old Cultures.

In order to determine the length of time which the fungus would retain its vitality in cultures, transfers were made from

time to time from prune agar and prune decoction cultures in both of which the fungus produces both conidia and ascospores. These cultures were kept at the temperature of the laboratory. It was found that growth took place readily when transfers were made from prune agar cultures up to 5 months old provided the agar had not become dried out. In no case was growth obtained from agar tubes in which the agar was dry. Growth took place when transfers were made from prune decoction cultures 6 months old. At that time, the liquid was almost all evaporated and the tests were not carried further.

Endomyces Magnusii.

A culture of this fungus was secured from the Association Internationale des Botanistes and has been grown upon a number of the same culture media under the same conditions for comparison. This species has been studied by Ludwig (10), Brefeld (1), and Hansen (6), all of whom grew the fungus in culture on a number of media. Their accounts agree for the most part. A branched mycelium is produced, the cells of which separate very readily to form oidia. Brefeld found that when the mycelium was grown in such a way that it was buried by the culture medium it did not break down so readily to form oidia and asci were formed. Hansen did not find the asci in any of his cultures, but his description of the mycelium and oidia agrees with those of Brefeld and Ludwig.

In this study, *Endomyces Magnusii* has been grown on the following culture media: Prune agar, potato agar, bean agar, prune decoction, bean pods, potato, turnip, carrot and beet cylinders, sterilized oak wood, 1 per cent dextrose, saccharose, lactose, and mannite agars, 2 per cent broths of the same 4 sugars, 2 per cent dextrose gelatine, 5 per cent glycerine broth, 5 per cent glycerine agar, and in both alkaline and acid milk. The fungus grew well in all of these media except in mannite, lactose, and glycerine agars and broths and alkaline milk. When the milk was made acid, the growth was good. In all of the media which were used, the fungus goes through the same stages. First, there is a development of mycelium which very soon breaks down to form oidia. After a little time, the oidia become quite thick walled and in some cases almost spherical. In none of these cultures have asci been found although they have been searched for repeatedly.

Attempts have been made to produce the asci by sowing the oidia in petri dishes in 5 c. c. of agar or gelatin and then after this was solidified adding enough gelatin to almost fill the dish. In this way a considerable amount of buried mycelium was produced in some cases but no asci. It seems that the asci must require very special cultural conditions for their development. The readiness with which the cells of the mycelium separate to form oidia is illustrated by the behavior in hanging drop cultures. When the rounded, thick walled spores were sown in hanging drops of prune decoction they germinated readily. After 18 hours, nearly all had pushed out germ tubes, and when the germ tube reached a length of about 3 times the diameter of the spore a cross wall was formed. After only a few cells were formed, they began to separate to form oidia. At the end of 48 hours the drops were filled with the one celled rounded oidia.

It is of considerable interest to compare the cultural characters of *Endomyces Magnusii* and of the *Endomyces* from apple. It has been seen that while their characters are very different each one retains its characters even when grown under a wide range of conditions and does not vary to any great extent. For example *Endomyces Magnusii* forms oidia in large numbers in all the culture media used either solid or liquid and does not form asci readily in cultures while the *Endomyces* from apple never forms oidia under any of the conditions which have been tested and produces asci readily in most of the culture media.

Another interesting point of difference is in their growth in fermentation tubes. *Endomyces Magnusii* does not form gas in 2 per cent lactose, and 2 per cent mannite broth but it does form gas in considerable quantity in 2 per cent dextrose and in 2 per cent saccharose broth. In dextrose broth at room temperature gas began to appear on the fifth day and increased rapidly in amount until the eighth day when the gas occupied about 80 per cent of the closed arm in each case. Most of the gas formed was carbon dioxide. In saccharose broth the amount of gas was less, being about 50 per cent of the closed arm.

In connection with the statement of the fact that *Endomyces Magnusii* ferments dextrose and saccharose with the formation of gas, attention should be called to the conclusions of Ludwig, Hansen and Brefeld in regard to fermentation by this fungus.

Ludwig discovered the fungus in fermenting sap of the oak and he also found a yeast-like form associated with it which he regarded as belonging to the *Endomyces* and he therefore regarded *Endomyces Magnusii* as the cause of the fermentation. Hansen (6) made a careful study in which by means of gelatin plates he secured cultures of the *Endomyces* from single oidia. He also secured pure cultures of the yeast form of Ludwig from single cells. He found the two forms to be entirely distinct as no yeast form developed in his cultures of *Endomyces Magnusii.* He described the yeast as a new species, *Saccharomyces Ludwigii.* Hansen grew both of these organisms in a considerable number of liquid media including solutions of sugars, extracts of a number of common fruits, and beer wort. He found that either one growing in pure culture caused fermentation of dextrose and saccharose but that neither caused fermentation of lactose. Hansen did not find the asci in his study of *Endomyces Magnusii* and he regarded it as doubtful whether the asci described by Ludwig belonged to the same fungus as the oidia and mycelium. In a later paper, Ludwig (11) stated that he had found asci on mycelium which was also forming oidia and as has been stated Brefeld secured the asci in culture under special conditions. Brefeld makes the statement in his account of *Endomyces Magnusii* that it does not cause fermentation of fermentable liquids but he does not give an account of the work by which this was determined and so it is impossible to know what liquids were tested. My work confirms the account given by Hansen (6) that *Endomyces Magnusii* causes fermentation of dextrose and saccharose with formation of gas, but it does not ferment lactose.

Another place in which *Endomyces Magnusii* and the *Endomyces* from apple differ is in their effect upon gelatin when grown in dextrose gelatin. *Endomyces Magnusii* does not liquefy gelatin while it has been shown earlier in this paper that the *Endomyces* from apple does cause considerable liquefaction.

In relation of growth to acids, the two fungi agree rather closely. With most of the acids used the limits of growth were found to be about the same, but there were some exceptions. In oxalic acid there was no growth of *Endomyces Magnusii* at +80 and in tartaric acid there was no growth at +400 and above. In lactic acid, however, this species grew a little better at the high acidities than the *Endomyces* from apple. Neither

of these species will grow in an alkaline medium. When grown in a medium containing sugar, *Endomyces Magnusii* does not cause as great an increase in acidity as is brought about by the *Endomyces* from apple.

Cytological.

Considerable work has been done in an attempt to study the *Endomyces* from apple from a cytological standpoint. The fact that it grows readily and produces asci and spores in abundance on a large number of culture media would seem to make it a favorable object for study, but the difficulties of securing good fixation and the small size of the nuclei have made it impossible to determine many of the important points which it is desirable to have cleared up in regard to the behavior of the nucleus and the method of spore formation in this group of fungi. A few things have been determined, however, which are of some interest.

Material for study was taken from actively growing cultures on prune agar and in prune decoction and also from apples which had been inoculated with the fungus and which were decaying. Material from such decaying apples showed large numbers of spore sacs and this seemed to be a very favorable place for the development of the ascospores. A number of fixing fluids were tried including Flemming's of different strengths, chrom-acetic acid, picric acid, picro-formol, and absolute alcohol. Some of the material from agar cultures and from decaying apples was imbedded in paraffin and sections were cut 5 and 8 microns in thickness. Sections were stained with Flemming's triple stain and with iron haemotoxylin. Some good preparations for determining certain points were prepared by teasing out material which had been fixed, and staining on the slide with iron haemotoxylin. The method followed in doing this was to prepare the slide with egg albumen fixative just as for fastening sections to slide, then material which had been run down from higher grades of alcohol to 30 per cent alcohol or water, was teased out on the slide and the alcohol or water was allowed to evaporate, care being taken that the slide did not become entirely dry. When almost dry the slide was placed in absolute alcohol which coagulated the albumen and fastened the material to the slide. Such material was stained with iron haemotoxylin. Some of the best preparations were from material grown in

prune decoction and fixed in picro-formol and in absolute alcohol.

The conidia of this fungus are uninucleate. When a conidium germinates, it becomes very much swollen and usually puts out a single germ tube. The nucleus moves over to the side of the conidium from which the germ tube grows but does not move out much into the germ tube. When the germ tube has grown out to some length the nucleus divides and one of the daughter nuclei moves out into the germ tube which then divides by a cross wall giving two cells each of which contains a single nucleus. By further growth and division, a branched mycelium consisting of many cells is formed. Each cell is uninucleate. This differs from what Miss Stoppel (15) found in *Eremascus fertilis* in which the number of nuclei in the cells varies from one to 15, and in which 6 to 8 nuclei are found in the germ tube.

The ascus develops from a single branch from the mycelium and not from a fusion of two branches as is the case in *Eremascus*. One or more asci may develop from a single cell, Fig. 65. There is no fusion of nuclei in the ascus and none has been observed in the mycelium preceding the formation of the ascus. The nucleus does not move out into the developing ascus until the outer end of the branch has rounded out and has attained some size. The writer has observed a considerable number of cases in which a single nucleus had moved only part way into the ascus when the material was fixed. A number of cases have been observed in which it appeared that the nucleus divides at the opening of the branch from the cell of the mycelium, one nucleus going into the young developing ascus and the other remaining in the cell. It would seem that such a division would be necessary in the case of cells which produce more than one ascus. Two cases in which division is taking place at this point are shown in Fig. 70. It has not been possible to determine whether the nuclear divisions are mitotic or amitotic. In some cases, there is somewhat the appearance that would be given by the threads of a low form of spindle connecting the chromatin which is to form the two nuclei or the same appearance might be given by the separating of two nuclei formed by direct division. The nuclei are small but the greatest difficulty is that no method of fixation which I have tried brings out the nuclear figures with sufficient clearness to enable one to determine with

certainty exactly what takes place in the dividing nucleus. The same difficulty has been encountered by a large number of investigators who have studied the yeasts and other low forms of Ascomycetes and hence there is much confusion in the accounts given by different writers.

The young ascus becomes almost spherical in most cases and enlarges to the size of the mature ascus before the nucleus divides. After the single nucleus has passed into the rounded part, this portion is cut off by a cross wall. The young ascus contains granular cytoplasm which surrounds a rather large central vacuole. The nucleus as a rule occupies a position in that part of the ascus which is opposite the stalk. The nucleus, in material which is well fixed, shows very much the same structure which as been described for the nucleus of *Saccharomyces* by Guillermond (4). There is a nuclear membrane, a small amount of chromatin, and a small spherical body which appears to be a nucleolus. This body stains red with the safranin of the triple stain. Unless material is well fixed and carefully stained it is impossible to distinguish the nucleolus from the chromatin and there appears to be a single dense mass inside the nuclear membrane.

With regard to the method of nuclear division in the ascus, little could be determined. In the first division, figures have been observed which might be interpreted as mitotic divisions with the chromatin which is to form the daughter nuclei still held together by the spindle, but the same appearance might be given by the separation of the two nuclei after an amitotic division.

Four nuclei are produced by a second division and these become the nuclei of the 4 ascospores. On account of the extremely small size of the nuclei and of the spores when first formed, it has not been possible to determine the exact method by which the spores are formed. It has been found, however, that the young ascospores are surrounded by an epiplasm as is the case in typical Ascomycetes. The young spores increase in size until when mature they almost fill the ascus. The membrane of the spore becomes thickened to a rather heavy wall. The spore contains a single nucleus.

The cytoplasm of the developing ascus seems to be of different composition from that of the mycelium and conidia. If one treats material consisting of young asci, mycelium, and conidia

with iodine in potassium iodide, the mycelium, conidia and the very young asci are not stained, but asci which have begun to swell out into the spherical form and those which are older are stained brown. The ascospores are also stained brown by the iodine. Schiöning has observed the same in the case of *Saccharomycopsis capsularis* Schiöning.

Systematic.

As was stated in an earlier part of this paper, if we classify this fungus according to the classification given by Schröter (12) it would be placed in the genus *Endomyces,* and it has also been shown that this species differs from any of the described species of that genus. There would be another possibility in its classification and that is that it might belong among the filamentous forms of the *Saccharomycetaceae.* The classification of the Saccharomycetaceae has been discussed by Hansen (7) and by Guillermond (4). Miss Stoppel (15) also gives briefly the characters of the genera and also the characters of *Endomyces* in her paper on *Eremascus fertilis.*

The relationship between the Saccharomycetaceae and the Endomycetaceae seems very close. Such a form as *Saccharomycopsis capsularis,* for example, which has a well developed mycelium, and in which cells of the mycelium develop into asci bears a very close relation to an *Endomyces* in which the asci are formed on short branches from cells of the mycelium. *Saccharomycopsis* however, produces yeast like cells which multiply by budding, Schiöning (13) in his study found that it was possible to cause this fungus to develop in that way with almost no production of mycelium in certain culture media and that, on the other hand, in certain other culture media there was a good development of mycelium and not much of the yeast form. None of the species of *Endomyces* develop typical yeast like forms in culture. In *Endomyces decipiens* and *Endomyces Magnusii* the cells of the mycelium separate as oidia but there is no yeast like budding. In the fungus from apple described in this paper, conidia are produced on short conidiophores, and in some cases in liquid media, the conidia develop from short germ tubes as shown in Fig. 67. There is, however, no typical yeast like budding as the writer understands that term.

The Endomycetaceae cannot be separated from the Saccharomycetaceae on the basis of fermentation because in both fam-

ilies there are species which cause fermentation of certain sugars and other species which do not cause fermentation. *Endomyces Magnusii* and *Endomyces fibuliger* Lindner (9) cause fermentation.

On the basis of a sexual fusion of cells or of nuclei before the formation of endospores there is no reason for placing the Saccharomycetaceae in the Hemiascomycetes and the Endomycetaceae in the Euascomycetes because in both families there are species in which the ascus develops from such a fusion and other species in which the ascus develops without such fusion. Guillermond (5) gives a good discussion of this point with regard to the Saccharomycetaceae and shows that in some of them two vegetative cells fuse before the ascus is formed, in others there is no such fusion but the ascospores fuse in pairs upon germination ,and in some others as *Saccharomycopsis,* there is neither a fusion of cells before the formation of the ascus nor a fusion of the spores upon germination. In the Endomycetaceae, according to Schröter, there is included one genus, *Eremascus,* in which there is a fusion of cells before the ascus develops. In *Endomyces Magnusii,* there are some cases in which there is a fusion of cells before the ascus develops and other cases in which the ascus develops from a single branch from a cell of the mycelium. Whether there is a fusion of nuclei in this species has not been determined. In the other species of *Endomyces* the ascus develops from a single branch but it has not been determined whether there is a fusion of nuclei before the ascospores develop.

In the fungus which has been described in this paper, the ascus develops from a single branch from a cell of the mycelium and a single nucleus passes into the young ascus. There is no fusion of germ tubes at the time of germination. We have here then a fungus which corresponds with those yeasts in which there is no sexual fusion of cells either before or after formation of ascospores. So far as the development of mycelium or the formation of ascospores is concerned there would seem to be little basis for placing a fungus like *Saccharomycopsis capsularis* in the Hemiascomycetes and the fungus described in this paper in the Euascomycetes. However, the fact that this fungus does not reproduce by typical yeast like budding would prevent its being classified in the Saccharomycetaceae. It has seemed best to the writer, therefore, to classify it as a new species of the genus *Endomyces.*

Whether the spore sacs of the yeasts or of *Endomyces* should be regarded as true asci has been questioned. Brefeld regards the spore sacs in yeasts as sporangia and he considers such forms as *Endomyces* to be more highly developed than the yeasts because the number of spores in the spore sac has become more definitely fixed than in the yeasts. There are, however, certain species among the yeasts in which the number of spores seems to be as definite as in *Endomyces*.

Harper (8) has shown that the spore formation in asci differs from that in sporangia and that the young ascospores are cut out of the cytoplasm in such a way that they are surrounded by epiplasm while this is not the case in sporangia. Guillermond (5) has shown that the young ascospores in certain yeasts are surrounded by epiplasm, and Miss Stoppel (15) has shown that the same is true in *Eremascus fertilis*. In the *Endomyces* described below the writer has found the same condition. It is desirable that further cytological study should be made upon species of the Hemiascomycetes and upon the lower forms of the Euascomycetes as it seems probable that such study will lead to a clearer understanding of the relationship of these forms to each other and to the higher Ascomycetes.

Description of Species.

Endomyces mali n. sp. Branched mycelium with cross walls develops in a large number of culture media, conidia averaging 3 x 8 microns formed on short conidiophores or on the ends of short germ tubes, no typical yeast like budding, asci 11-14 microns in diameter, usually formed singly on short side branches of the mycelium without fusion of cells or nuclei, ascospores almost spherical but slightly elongated 4.5 x 5.5 microns, thickened places on walls, brown when mature. Fungus grows well in large number of culture media, in liquid media, as prune decoction, a pellicle is formed in one to 2 days composed of mycelium and conidia, mycelium in liquid as well as at surface, asci produced in 5-8 days both at surface and in liquid. Cultures take on a brownish color after ascospores are formed. No fermentation with formation of CO_2 in dextrose, saccharose, lactose, mannite or glycerine broth. Requires acid culture media for growth.

Found in decaying fruit of apple, Orono, Maine, causes small amount of decay of ripe apples.

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FIG. 58. Photograph of apple 2 weeks after inoculation with *Endomyces mali.*

FIG. 59. Photograph of the same apple cut in two to show extent of the decay.

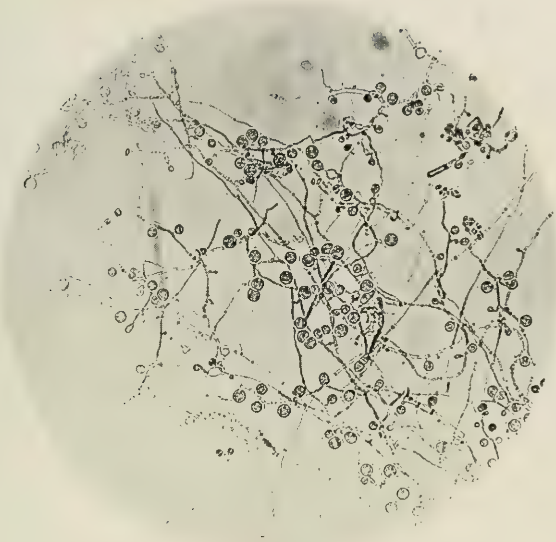


FIG. 60. Photo-micrograph of mycelium and young spore sacs of *Endomyces mali*. x 180.

FIG. 61. Spore sacs and mycelium. x 350.

FIG. 62. Spore sacs more highly magnified. x about 800.

FIG. 63 Spore sacs which contain spores. x about 800.

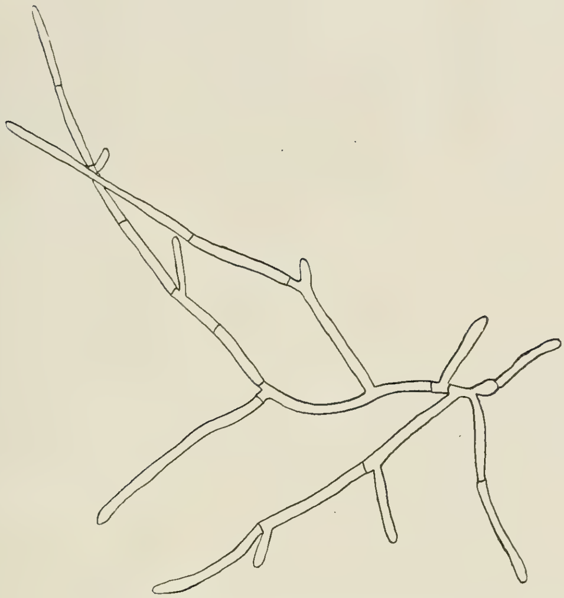


FIG. 64. Mycelium from a single conidium after 42 hours in bean agar. x 350.

FIG. 65. Drawing of young spore sacs from unstained material. Nuclei cannot be seen here, a large vacuole in each ascus. x 480.

FIG. 66. Typical manner of bearing conidia on agar.

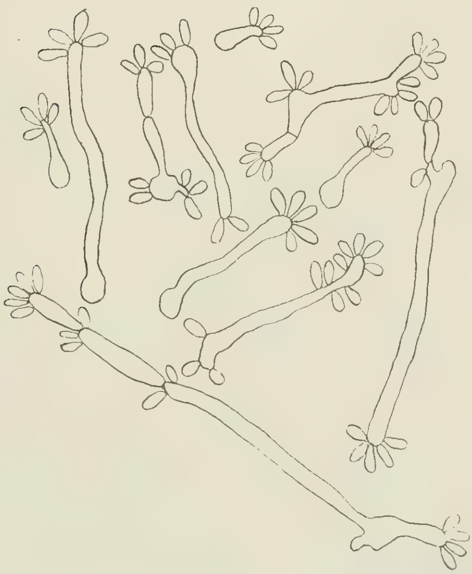


FIG. 67. Conidia formed on short germ tubes in hanging drop, prune decoction, after 18 hours. x 480.

FIG. 68. Conidia germinating in hanging drop, prune decoction. At the left unstained, at the right stained to show nuclei.

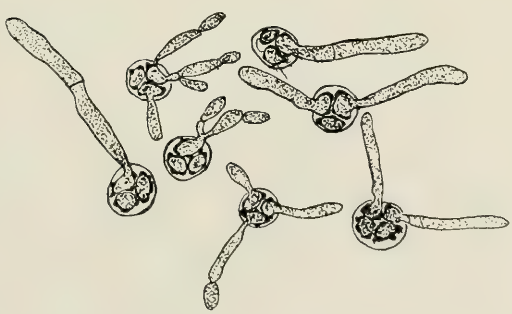


FIG. 69. Germinating ascospores.

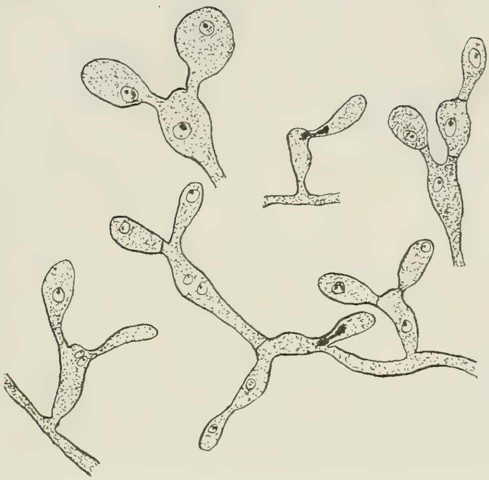


FIG. 70. Young spore sacs formed in irregular ways. Stained to show nuclei. x 800.

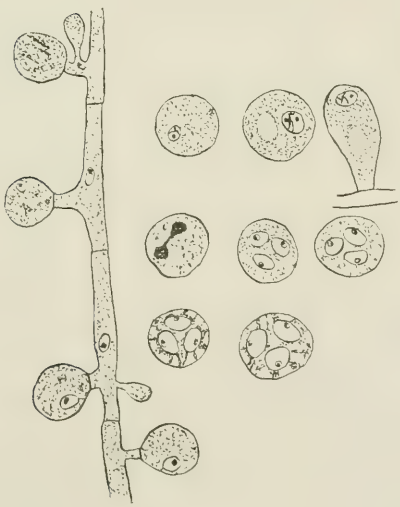
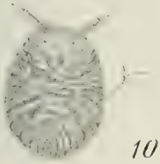


FIG. 71. At the left, young spore sacs 4 of which contain single nuclei the nucleus has not moved into the younger ones; at the right above, 3 young asci showing typical nuclei, below, asci with young spores surrounded by epiplasm.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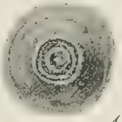
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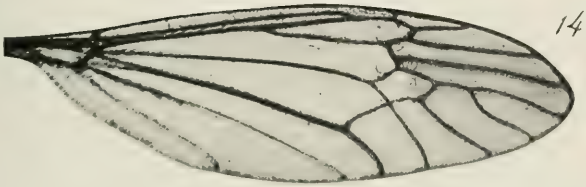
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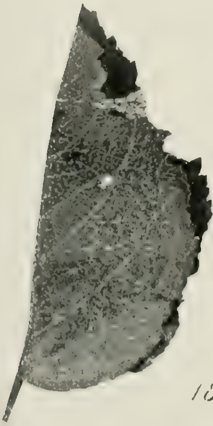

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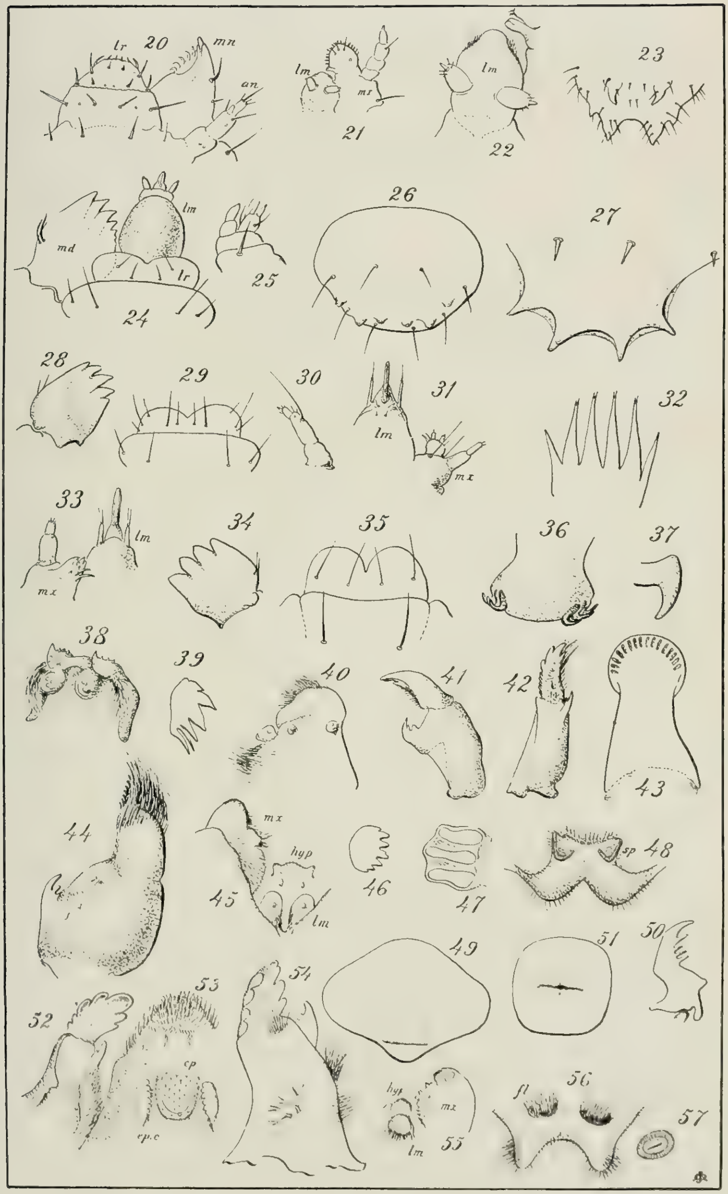

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BULLETIN No. 179.

POULTRY NOTES—1909.

RAYMOND PEARL AND FRANK M. SURFACE.

The purpose of this bulletin is to present a brief report of the progress of the work of the Station with poultry during the year 1909. The publication of such summary reports annually is a definite policy of the Station. It is the object of these reports not only to give an account of the work done, but also to present a more or less complete account of various points regarding poultry management, which arise incidentally in connection with the main lines of investigation which are being followed with poultry. These main lines of investigation are poultry breeding, particularly for increased egg production, and the physiology of egg production. No topics will be discussed in this bulletin which have been, or are to be treated in other bulletins of the Station.

FEEDS AND METHODS OF FEEDING.

When the new experiments in breeding were inaugurated at the Maine Station in 1907 and 1908* it seemed desirable to examine thoroughly the methods of management which had been so long used here, with the view of determining whether it might not be well to make some changes before embarking on another long period of breeding work. It is obvious that changes in management cannot be made during the course of a breeding experiment without interfering seriously with the interpretation of any results obtained. Any new methods of management, feeding, etc., which one wishes to use, must be inaugurated at the beginning of the experiment, and adhered to throughout.

*Cf. Me. Agr. Expt. Stat., Bulletins 157, 159 and 166.

Upon reviewing the whole subject of the methods of handling poultry in operation at the Station it finally seemed advisable to make some changes. These changes were made in 1908, and have now been tried for two years. We have been so well pleased, on the whole, with these new feeds that it is proposed to publish them at this time. The following topics are here discussed:

1. Feeding the laying pullets.
2. Feeding the hens, cockerels and cocks kept over the winter for breeding purposes.
3. Green food for poultry.

FEEDING THE LAYING PULLETS.

The feed of all adult birds, whether pullets or not, consists of two essential parts: (a) the whole or cracked grains scattered in the litter, and (b) the mixture of dry ground grains which has come to be generally known as a dry mash. These two component parts of the ration and the methods of feeding them will be considered separately. In addition to the grains and dry mash, oyster shell, dry cracked bone, grit, and charcoal are kept in slatted troughs, and are accessible at all times. Plenty of clean water is furnished. About 5 pounds of clover hay cut into ½-inch lengths is fed dry daily to each 100 birds in winter. When the wheat, oats, and cracked corn are given, the birds are always ready and anxious for them, and they scratch in the litter for the very last kernel before going to the trough where an abundance of feed is in store.

It is very evident that the hens like the broken and whole grains better than the mixture of the fine, dry materials; yet they by no means dislike the latter, for they help themselves to it, a mouthful or two at a time, whenever they seem to need it, and never go to bed with empty crops, so far as noted. They apparently do not like it well enough to gorge themselves with it, and sit down, loaf, get overfat, and lay soft-shelled eggs, as is so commonly the case with Plymouth Rocks when they are given warm morning mashes in troughs.

Some of the advantages of this method of feeding are that the mash is put in the hoppers at any convenient time, only guarding against an exhaustion of the supply, and the entire

avoidance of the mobbing that always occurs at trough feeding when that is made a meal of the day, whether it be at morning or evening. There are no tailings to be gathered up or wasted, as is common when a full meal of mash is given at night. The labor is very much less, enabling a person to care for more birds than when the regular evening meal is given.

Taking first the dry grains, the following may be said in regard to the method in which they are fed: Early in the morning for each 100 hens 4 quarts of whole corn is scattered on the litter, which is 6 to 8 inches deep on the floor. This is not mixed into the litter, for the straw is dry and light, and enough of the grain is hidden so the birds commence scratching for it almost immediately. At 10 o'clock they are fed in the same way 2 quarts of wheat and 2 quarts of oats. This is all of the regular feeding that is done.

The litter which the Station now uses for its houses in preference to all others which have been tried, consists of a mixture of dry pine shavings and straw. The shavings can be obtained in this part of the country from box mills in bales, which are sold at a price of about 10 cents per bale. These shavings are spread on the floor of the pen to a depth of some 5 to 7 inches. From 6 to 8 bales will cover the floor of a pen which accommodates from 100 to 125 birds. On top of these shavings is spread a thin layer of straw. Straw which has not been baled is preferred because it is less liable to be broken and will consequently wear longer in the pen. This combination of straw and shavings gives excellent satisfaction as a litter. The straw serves the purpose of protecting the shavings so that they last a longer time than would otherwise be the case before they are finally worked up into a mass of fine material which packs down and becomes damp. The shavings become damp much less quickly than does a litter of straw alone. This is because they are finer, and the birds can keep them worked over much more thoroughly. This constantly exposes and dries out new portions of the mass of litter. Using this combination of shavings and straw it is not usually found necessary to change the litter in the pens oftener than once in three months.

It is in regard to the dry mash portion of the ration in which the changes already referred to (p. 66) have been made. The dry mash which was *formerly used* at the Station had the following composition:

	Pounds
Wheat bran	200
Corn meal	100
Middlings	100
Gluten meal or brewers' grains	100
Linseed meal	100
Beef scrap	100

The experience of the Station with this mash extending as it has over a number of years has indicated that it was somewhat too rich. The relatively large amount of such concentrated feeds as linseed meal and gluten meal seemed to make too rich a ration for the well-being of the fowls. During the years when this mash was fed more or less difficulty was always experienced with liver troubles in the birds. Birds died with all the symptoms that would be expected to come from indigestion arising from feeding too rich food.

In planning the new dry mash ration consideration was given to the physiological conditions under which the birds developed and under which they were placed in the laying houses. It is evident that the bringing of the birds in from the range upon which they have grown from little chickens, into the laying houses, is apt to be a very violent and abrupt transition. It has seemed in studying the birds in the fall of the year that this change was an important time in the life of the bird, and that the results during the subsequent winter with reference to egg production depended much upon the way the transition from range conditions to the laying house was made. It seemed advisable both on general grounds and from observation of the birds themselves to make this change as gradual as possible. With this idea in mind the pullets have been brought into the houses from the range much earlier during the past few years than was the custom before. It is the custom at the present time to bring in the pullets from the range as soon as possible after the first of September.

When the pullets are brought in as early as this it is not, of course, advisable to shut them up entirely in the houses at once. On the contrary, the work is planned in such a way that there is always a freshly seeded yard full of green grass for the birds to run in after they are brought into the house until cold

weather sets in in the fall. In other words, the birds are brought from free range into a condition of restricted range, but with better pasturage on the restricted than on free range. The yards are freshly seeded and have not been trampled down or burned and dried out by the sun, as is the grass on the open range from which the birds are taken. In this way the attempt is made to have the transition from open range conditions to house conditions as gradual as possible. After about two months, or occasionally even a little longer of restricted range, the birds are finally shut up in the curtain front house for the winter season.

Further in accordance with this idea of gradual change it is thought wise not to put the pullets which are brought in from the free range conditions abruptly on to the heavy, forced-laying mash which it seems to be necessary for them to have during the winter months if they are to do their best in the way of egg production. It has been said that a hen will not lay her best unless she is on full feeding. This is quite true, but it is probably equally true that a great deal of harm can be done to a pullet in regard to her future egg production by abruptly bringing her from free range conditions into restricted yards or to entire confinement in the house and putting her on a heavy, rich laying mash like the one which was formerly fed at this Station. On the contrary, it seems reasonable to bring the birds more gradually on to this rich ration. It is in accordance with this idea that the dry mash feed which is now used at the Station has been planned. The formulas and method of feeding this new dry mash are given below. It will be noted that the mash is made richer in successive months. These formulas are planned on the assumption that the pullets will be brought into the winter laying quarters sometime during the month of September.

Composition of Dry Mash Fed to Laying Pullets.

First month in laying house (September):—

Bran	300 lbs.
Corn meal	100 lbs.
Middlings	100 lbs.
Meat scrap	100 lbs.

Second month in laying house (October) :—

Bran	200 lbs.
Corn meal	100 lbs.
Middlings	100 lbs.
Gluten meal	100 lbs.
Meat scrap	100 lbs.

Third month in the laying house (November) :—

The mash has the same composition as that of the second month given above *with the addition of 50 pounds of linseed meal.*

Fourth month in the laying house :—

The mash has the same composition as that of the second month given above.

Fifth month in the laying house :—

The mash has the same composition as that of the third month as given above.

From this time on 50 pounds of linseed meal are put into the mash as given for the second month above every alternate month. That is to say, one month linseed meal is fed and the next month it is not.

This dry mash made as described above is kept before the birds all the time in open hoppers of the type which has been described in previous publications from this Station.*

The advantages which it is believed have resulted from this method of feeding the laying pullets are two fold: first, in the good effect on the vitality of the birds, and, second, in its effect on the evenness of egg production during the winter months. It is a fact well known to poultrymen that if pullets are too rapidly forced for egg production in the early fall there is a marked tendency for them to moult during the winter at just the time when they should be doing their best work in egg production. Since adopting the method of feeding the pullets described above, not only have the birds been much freer of digestive troubles and diseases involving the liver, but also there has been no moulting in the early winter after a short spurt of egg production in the fall months. On the contrary the egg production on this plan begins in September and gradually and steadily increases through the winter months. During the past

*See Farmers' Bulletin 357 for a description of these hoppers.

two years while this method of feeding has been used, there has been hardly a pullet in winter moult, whereas on the old system of feeding such birds were common every year.

The character of the egg production under this method of feeding is well shown in Table 1 and graphically in Figure 72.

TABLE 1.

Egg Production of 300 Barred Plymouth Rock Pullets, Fall and Winter of 1909.

MONTH.	Total number of eggs laid.	Average per bird.
September	139	.46
October	725	2.42
November	984	3.28
December	2.926	9.75
Totals	4.774	15.91

This table shows the total number of eggs and the average number of eggs per bird laid by 300 Barred Plymouth Rock pullets put into the laying house on September 1-3, 1909. These birds were intended for trap nest tests in connection with experiments in breeding for egg production. They were all pedigreed birds. It will be seen from the figures of the table that the average production made no sudden spurt in the early fall but came up gradually until in December when it rose quite rapidly at just the time of year when a high egg production is most desired. The November average of 3.28 eggs is slightly below the general average November production for the Maine Station birds over a period of 8 years.* The November average for the 8-year period was 4.63 eggs. It thus appears that the birds in 1909 laid about one egg less in November than the general average of the flocks over the long period. This defect in November, however, is offset by the favorable difference for December. The December average for the 300 birds this year, as

*Cf. Bureau of Animal Industry Bulletin 110, Part II. (In press).

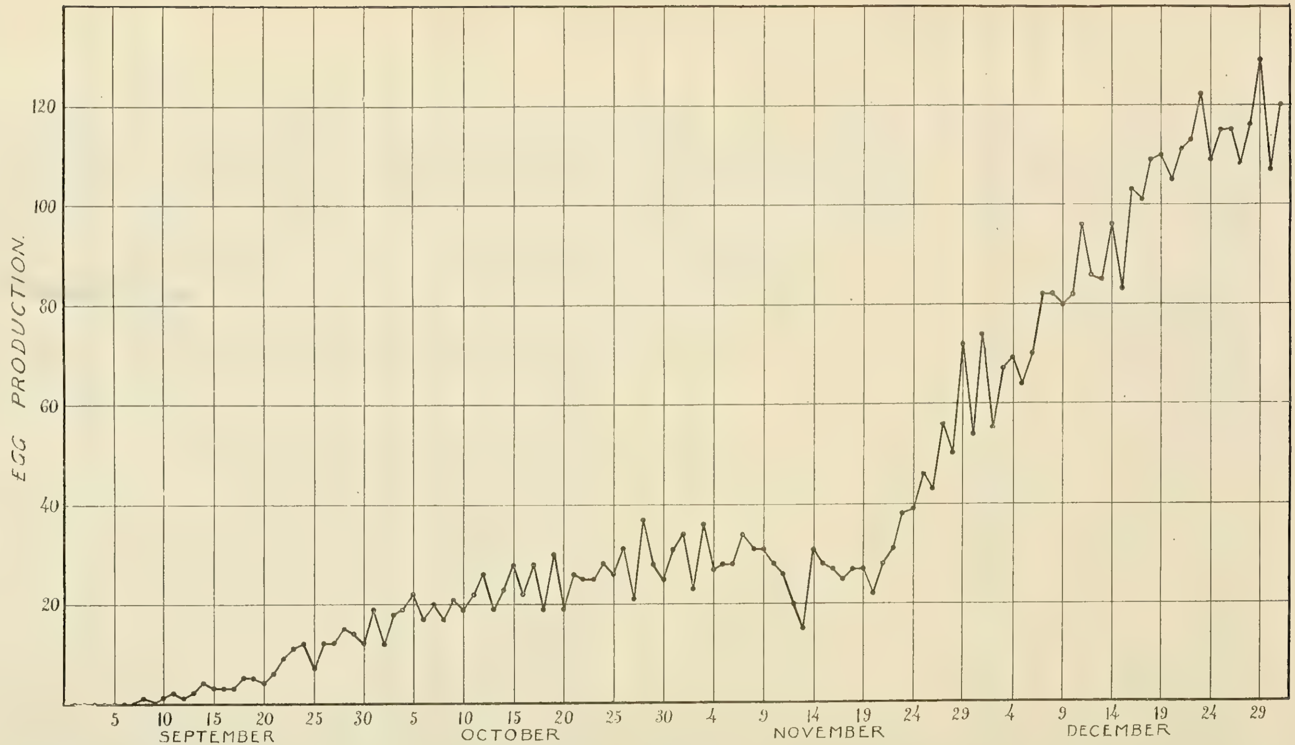


Fig. 72. Diagram showing the daily egg production of 300 Barred Plymouth Rock pullets put into the laying house at the beginning of September, 1909. The ordinates give the absolute number of eggs produced on each of the dates given along the base. This diagram includes the egg production from September 1 to December 31. If the line were to be continued it would show a decline during the month of January to be followed by a rise in the latter part of February and March.

shown in the table is 9.75, whereas the 8-year general average of the Station flocks is only 8.91. Reckoning the average net return on eggs for the four months of 1909 covered in the table to have been 40 cents per dozen, which is as near as can be estimated to what the Station actually received for these eggs, it appears that *each one of these 300 pullets had averaged to return to the Station 53 cents in eggs alone before January 1 of her pullet year.*

The facts regarding egg production are brought out by Figure 72 in another way. This diagram shows the daily egg production for each day after the birds were put into the house in September. The abscissae give the days of the month and the ordinates the number of eggs produced by the 300 pullets on each day. The daily production curve is here taken only to the end of December. It will be noted that there is a gradual and steady increase in egg production from early in the month of September until well on in November, then there is a slight decline in the curve, which from the low point reached rises very rapidly to a maximum point at the end of December. It should be said that this high point at the end of December really represents the winter maximum. From that point on the curve declines to a February minimum, which has been found to be a characteristic of egg production curves at this Station. The daily egg production curve for the fall of 1908 shows an even more steady rise from its beginning in September up to the February drop than does this curve for 1909. It is not necessary, however, to illustrate here more than the daily curve for one year, and 1909 has been chosen for the purpose.

FEEDING THE HENS, COCKERELS AND COCKS KEPT OVER THE WINTER FOR BREEDING PURPOSES.

Observations made in connection with the work of this Station, as well as a study of the literature which exists upon the subject, have led to the opinion that in order to get the best results in respect to the fertility and hatching quality of eggs it is not desirable to feed birds which are to be used as breeders the heavy laying ration which is used to force egg production during the winter months in pullets. The feeding of such rich food has a tendency, it is believed, to reduce or impair the fertility and hatching quality of the eggs. Therefore, a plan of

feeding birds kept to be used as breeders has been devised with the idea of getting over this difficulty so far as possible. This method of feeding is used for old hens, cockerels and cock birds which are kept from one season to another for breeding. The aim is to keep these birds on as light a ration as is consistent with the maintenance of good condition until just before the beginning of the breeding season when they are to be used and then to put them on a more stimulating and richer ration. The scratch food given to this breeding stock is the same as that given to the pullets, namely, corn for the first morning feed and a mixture of wheat and oats for the second feed of the day, both scattered in the litter. If, however, there is any tendency for the yearling hens kept as breeders to get unduly fat during the winter corn is not fed as a litter grain. The hens, under such circumstances, are simply given the mixture of wheat and oats at both feedings.

The dry mash used for these birds kept as breeders has the following composition:—

Bran	400 lbs.
Corn meal	50 lbs.
Middlings	50 lbs.
Meat scrap	100 lbs.

Birds kept over from one season to another are managed in the following way. The birds completing their pullet year which are to be kept as breeders are continued on the usual pullet ration until after they have finished their moult in the early fall, usually in September or early October with the birds here. Immediately after the moult is over and the hens are well feathered out they are put on the dry mash ration given above. They are fed in the way described until about a month before the beginning of their second breeding season. At this Station the breeding pens are usually mated up about the first of February. About a month before this time the birds to be used as breeders (old hens, cockerels and cocks) begin to get richer food and are quickly worked on to the regular laying ration given to the pullets as described above (pp. 69-70) for the third month of the pullet year. Usually there is added to this ration a little more meat scrap than is indicated in the formula on p. 70. This has the effect of bringing the old hens into laying condition.

It has been the experience here that this method of feeding breeders appears to help towards good fertility and hatching quality of the eggs and vigor of the chicks. Usually when fed and managed in this way the old hens do not lay at all during the fall and winter months (October 1 to February 1).

GREEN FOOD FOR POULTRY.

There is a general unanimity of opinion amongst experienced poultrymen that poultry do best upon some form of green or succulent food during the winter months. The function of such succulent food is probably largely in the nature of a digestive stimulant, rather than as an addition to the actual food constituents of the ration. Formerly mangolds were used as a source of winter succulent food at this Station. They did not, however, prove entirely satisfactory. The chief difficulty with the mangolds was found in getting them properly grown so that they would keep fresh and plump during the winter. If mangolds are not ripened off and harvested in the proper manner they will not keep through the winter but will shrivel and become unfit to use as a succulent food. In the experience of the Station it is much better not to feed any green or succulent food at all than to feed withered, shriveled mangolds which were harvested before they were thoroughly ripe.

On account of this difficulty with mangolds as a source of winter green food, the Station began in 1908 some experiments with green sprouted oats as a source of such food. Green sprouted oats have been very widely exploited in recent years as a green food for poultry. There are some so-called "poultry systems" on the market which really consist of very little else than the use of this food. The first experiments with this material at the Station were not satisfactory. It was found difficult to get the oats to make a sufficiently quick growth. Experience here has indicated that in order to make a satisfactory green food the oats must be grown very quickly. In order to get quick growth it is necessary to have three things:—first, warmth; second, plenty of moisture; and third, sunlight. After a number of experiments to get the right combination of these three factors the plan to be described was finally worked out and has proven very satisfactory.

There is in connection with the Station poultry plant a hot water heating system which has a 3-inch out-go pipe. This out-go pipe as it leaves the heater passes along the rear wall of a small room which was formerly used as a grain storage room. To provide a place in which to sprout oats the back part of this room was partitioned off as a closet inclosing the 3-inch hot water pipe. The partition wall which forms the front of this closet consists of glass doors, made from regular storm window sash, hinged so as to swing open as an ordinary door does. These glass doors face towards the south side of the building which has a window directly in front of the doors. Throughout the day the closet gets plenty of light. The dimensions of this sprouting closet are as follows:—

Length.............9 ft. 3 inches
Depth..............2 ft. 6 inches
Height.............6 ft.

The place of shelves in this closet is taken by large, square green-house flats made of ⅞-inch stuff. These flats have the following dimensions:—

Length.............	2 ft. 5 inches	(inside)
Breadth...........	2 ft. 5 inches	(inside)
Depth..............	2 inches	(inside)

The length of the closet is such as just to accommodate three tiers of these flats, which slide on supports so that they can be moved in or out or turned around to suit the convenience of the operator, and the needs of the sprouting grain. These flats set 15 inches apart (i. e., vertically). There can be accommodated four rows of flats, three in a row, in the closet at one time. A number of holes are bored in the bottom of each one of the flats in order to drain off the surface moisture which comes with the wetting of the oats.

The arrangement of the sprouting closet and the flats is shown in Figs. 73 and 74.

The advantage of the closet arrangement described is that it enables one to control the three necessary factors of heat, moisture and light, quite completely. In this closet it is easily possible to maintain a temperature which does not run at any time below 70 degrees. The closet being perfectly tight it is possible

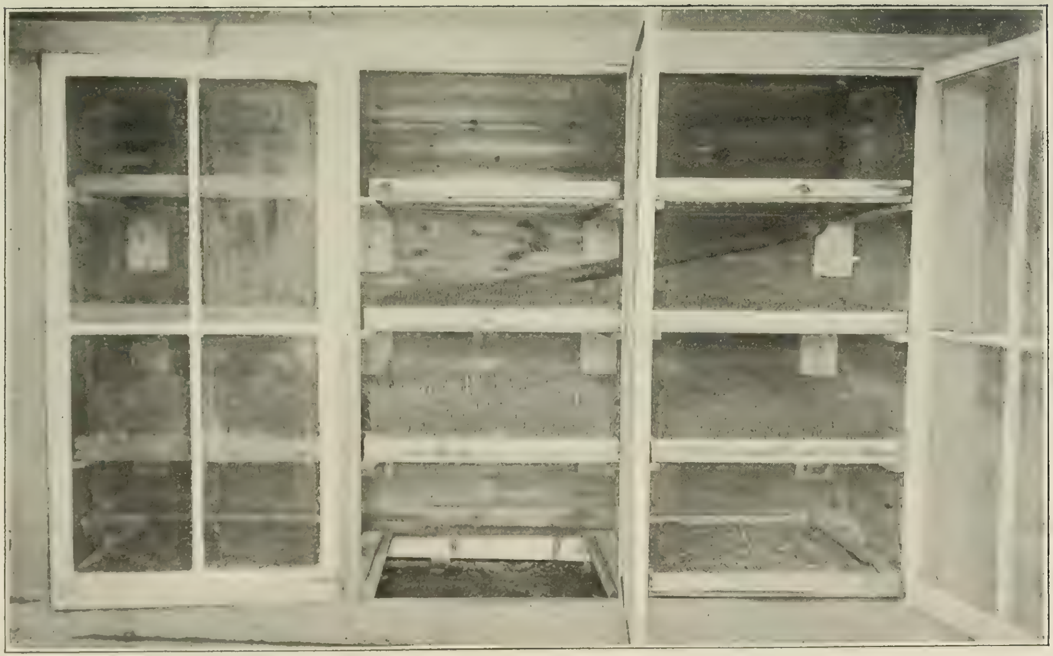
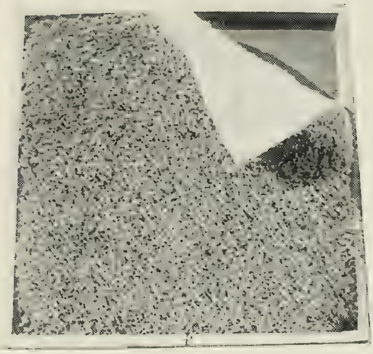


FIG. 73. Green Food Grower.

A



B

C

FIG. 74. A, empty flat. B, oats started to sprout. C, oats sprouted more.

to saturate the air with moisture quite easily and virtually convert the whole space into a great moist chamber. With this arrangement one is able to grow oats from 4 to 6 inches high in one week's time. The only difficulty with which one has to contend is the matter of mould. There is always a tendency for the oats to mould in the sprouting process. The only way in which it has been found possible to control this mould is by thoroughly cleaning the flats after each time when they are used. After a flat has been emptied it is thoroughly scrubbed with a 50 per cent. solution of formalin (that is, equal parts of commercial formalin and water). This scrubbing is very thoroughly done and sufficient formalin is used to soak the flat thoroughly. With this precaution, and if the oats are further made to grow rapidly, the mould does not give any trouble whatever.

The actual method of sprouting the oats is as follows: Clean and sound oats are soaked in water over night in a pail. The next morning flats are filled to the depth of about two inches, and put into the sprouting closet. At the beginning freshly filled flats are placed near the top of the closet so as to get the maximum amount of heat, and in that way get the sprouts started at once. During the first few days, until the sprouts have become from a half to three-quarters of an inch long, the oats are thoroughly stirred and raked over at least two or three times during the day. This stirring insures an even distribution of moisture throughout the mass of oats in the flat. After the sprouts become sufficiently long so that the oats form a matted mass it is not desirable to stir them, or to disturb them in any way. Stirring at that time will break off and injure the sprouts and the green portion above the mass will not grow so well. The matter of prime importance in growing the oats successfully has been found to be sufficient moisture. The tendency at first is to use too little moisture. The oats should be kept quite wet. The aim here is to keep condensed moisture standing on the glass doors which form the front of the closet at all times. In order to do this it is found necessary to wet the oats three times a day. This is done with an ordinary greenhouse sprinkling can, with very little expenditure of time or labor. As the oats grow the flats are moved to different positions in the closet. The taller the green material gets the nearer the flats are moved towards the floor, because the growing grain

then needs less heat. This procedure leaves the desirable places in the closet for the grain just beginning to sprout where high temperature is needed.

The oats are fed when they are from 4 to 6 inches in height. They are fed at the rate of a piece of the matted oats and attached green stalks about 6-8 inches square for each 100 birds per day. In feeding, this 6 to 8-inch square piece is broken into smaller pieces and scattered over the pen, so to ensure that all the birds shall have an opportunity to get some. Fed at the rate indicated, this material has never caused any bowel trouble among the birds.

It should be clearly understood that the purpose for which green sprouted oats are fed is their tonic and stimulative influence on the digestive organs. They are not fed for the food value of the oats themselves. If one wishes merely to feed oats they can be most economically fed not sprouted. The point of sprouting is to furnish fresh, succulent, *green* food during the winter months.

Keeping Poultry Free of Lice.

One of the most difficult and trying problems which the poultry keeper has to meet is that of keeping his poultry houses and stock reasonably free from lice, mites, and other external parasites. There are many proprietary preparations on the market designed to accomplish this end in one way or another. Most of these preparations are, in proportion to their efficiency, very expensive. Many of them have been tried at the Maine Experiment Station. The Station has finally, however, come to follow the procedure outlined in a circular, from which the present section of this bulletin is adapted, to the exclusion of all others, and with results which are extremely satisfactory. Indeed, it may be said that vermin on the poultry or in the houses no longer cause any appreciable annoyance in the work of the Station plant.

Formulae for the preparations which are in use at the Station were in the first instance given the writers of this bulletin by Mr. F. C. Lawry, formerly of the Poultry Department of Cornell University. These formulae were presented by Mr. Lawry to his classes for a number of years. The Poultry Department

of Cornell University has very kindly given its consent to the Maine Experiment Station to publish these methods for the benefit of those interested in poultry in Maine.

In keeping a poultry plant free from lice there are two points of attack: One, the birds themselves; the other, the houses, nest boxes, roosting boards, etc. For the birds themselves experience has shown that the best way to get rid of the lice is by the use of a dusting powder to be worked into the feathers. In using any kind of lice powder on poultry, whether the one described in this circular or some other, it should always be remembered that a single application of powder is not sufficient. When there are lice present on a bird there are always unhatched eggs of lice ("nits") present too. The proper procedure is to follow up a first application of powder with a second at an interval of 4 days to a week. If the birds are badly infested at the beginning it may be necessary to make still a third application. To clean the cracks and crevices of the woodwork of houses and nests of lice and vermin a liquid spray or paint is probably the most desirable form of application.

The original Lawry lice powder as described in the circular from this Station on the subject, was made by incorporating the liquid mixture of

3 parts of gasoline
1 part of crude carbolic acid

in sufficient plaster of paris to take up all the moisture. Since the publication of the circular two unforeseen difficulties have arisen regarding the practical utility of the powder as above described. In the first place a great many druggists in this State appear to have a deep-seated and ineradicable prejudice against furnishing their customers *crude* carbolic acid at any price. Reports have reached the Station of druggists making such utterly preposterous and absurd claims as that carbolic acid is a highly explosive substance, which they do not dare to handle! In the second place difficulty has arisen over the fact that there are in the drug trade three grades of crude carbolic acid. Two of these are very much weaker than the other and are quite useless for making the lice powder. The three grades are listed as follows by a reputable chemical house. These are retail prices.

Acid Carbolic, *Crude,* per gallon 25c.
Acid Carbolic, *Crude* 50-60 per cent., per gallon 40c.
Acid Carbolic, *Crude* 90-95 per cent., per gallon 50c.

To get the proper results *only the 90-95 per cent. should be used for making lice powder.* The weaker acids are ineffective.

Owing to the difficulty in getting the strong crude carbolic acid locally in this State at reasonable prices,* the Station has experimented to see whether some other more readily obtainable substance could not be substituted for it. It has been found that *cresol* gives as good results as the highest grade crude carbolic.

The directions for making the powder are now, therefore, modified as follows:

Take *3 parts of gasoline, and*
1 part of crude carbolic acid, 90-95 per cent. strength, or, if the 90-95 per cent. strength crude carbolic acid cannot be obtained take
3 parts of gasoline and
1 part of cresol.

Mix these together and add gradually with stirring, enough plaster of paris to take up all the moisture. As a general rule it will take about 4 quarts of plaster of paris to 1 quart of the liquid. The exact amount, however, must be determined by the condition of the powder in each case. The liquid and dry plaster should be thoroughly mixed and stirred so that the liquid will be uniformly distributed through the mass of plaster. When enough plaster has been added the resulting mixture should be a dry, pinkish brown powder having a fairly strong carbolic odor and a rather less pronounced gasoline odor.

Do not use more plaster in mixing than is necessary to blot up the liquid. This powder is to be worked into the feathers of the birds affected with vermin. The bulk of the application

*One report has come to the Station of a farmer being charged *$1.00 a quart* for the poorest grade of crude carbolic acid for which a rather high *retail* price is 25 cents a *gallon* as shown above! It may be said that the Station has been able to obtain carbolic acid of the grade desired from Mr. C. F. Nichols, Orono, Maine. Mr. Nichols is prepared to furnish the 90-95 per cent. crude carbolic to anyone at a price in reasonable accordance with that given above, making allowance for the cost of containers, packing, etc.

should be in the fluff around the vent and on the ventral side of the body and in the fluff under the wings. Its efficiency, which is greater than that of any other lice powder known to the writers, can be very easily demonstrated by anyone to his own satisfaction. Take a bird that is covered with lice and apply the powder in the manner just described. After a lapse of about a minute, shake the bird, loosening its feathers with the fingers at the same time, over a clean piece of paper. Dead and dying lice will drop on the paper in great numbers. Anyone who will try this experiment will have no further doubt of the wonderful efficiency and value of this powder.

For a spray or paint to be applied to roosting boards, nest boxes or walls and floor of the hen houses the following preparation is used:—*3 parts of kerosene and 1 part crude carbolic acid, 90-95 per cent. strength.* This is stirred up when used and may be applied with any of the hand spray pumps or with a brush.

If 90-95 per cent. crude carbolic acid cannot be obtained cresol may be substituted for it in this paint.

The routine methods which the Station uses in handling its stock with reference to the lice problem is as follows:—

All hatching and rearing of chickens is done in incubators and brooders. The growing chickens are never allowed to come into any contact whatever with old hens. Therefore, when the pullets are ready to go into the laying houses in the fall they are free from lice. Sometime in the late summer, usually in August or early in September, the laying houses are given a thorough cleaning. They are first scraped, scoured and washed out with water thrown on the walls and floor with as much pressure as possible from a hose. They are then given two thorough sprayings, with an interval of several days intervening, with a solution of cresol such as is described in the next section. Then the roosting boards, nests, floors and walls to a height of about 5 feet are thoroughly sprayed with the lice paint (kerosene oil and crude carbolic acid described above). Finally, any yearling, or older birds, whether male or female, which are to be kept over for the next year's work are given two or three successive dustings, at intervals of several days to a week between each application, with the lice powder described above, before they are put into the clean houses.

As a result of these methods the Station's poultry plant is at all times of the year practically free of lice.

Making Cresol Disinfecting Solution.

In Bulletin 165 of this Station directions were given for making a disinfectant for use in and about poultry houses which had as its basis the powerful germicide cresol. The method of making the compound solution of cresol described in that bulletin calls for the use of commercial potassium hydroxide or caustic potash. Since Bulletin 165 was issued correspondence has developed the fact that farmers in Maine have a good deal of difficulty in getting potassium hydroxide at a reasonable price from their druggists. The question has been frequently asked whether it would not be possible to use in place of the potassium hydroxide the ordinary commercial lye, or "potash" as it is incorrectly termed in the trade. The Station has tried experiments in making cresol soap with ordinary lye or "potash" with successful results. The following revised directions will show how the disinfecting solution can be made with the use of ordinary lye, "Babbit's potash," or other commercial "potashes" on the market.

Liquor cresolis compositus, or as it may for convenience be called, cresol soap, may be easily manufactured by any poultryman. The only requisite is a careful attention to the details in the process and a rigid following of the instructions given below. In order to make clear the reasons for the method of manufacture which will be outlined it may be well to give some account of the nature of the substance itself. The active base of cresol soap disinfecting solution is commercial cresol. This is a thick, sirupy fluid varying in color in different lots from a nearly colorless fluid to a dark brown. It does not mix readily with water, and, therefore, in order to make satisfactorily a dilute solution it is necessary first to incorporate the cresol with some substance which will mix with water and will carry the cresol over into the mixture. The commercial cresol as it is obtained, is a corrosive substance, being in this respect not unlike carbolic acid. It should, of course, be handled with great care and the pure cresol should not be allowed to come in contact with the skin. If it does so accidentally the spot should be immediately washed off with plenty of clean water. The price of commercial cresol varies with the drug market. It can be obtained through any druggist. On the day that this is written the quotation on cresol in the New York market is 24

cents per pound. In purchasing this article one should order simply "commercial cresol."

Since cresol will not mix with water some method of making it do so must be found if it is to be used as a disinfecting solution. The plan which has been adopted is to make a cresol *soap* which shall be, like other soaps, soluble in water and at the same time carry over into the solution a considerable amount of the cresol. This is done in the following way.

Measure out 3 1-5 quarts of raw linseed oil in a 4 or 5-gallon stone crock; then weigh out in a dish 1 lb. 6 oz. of commercial lye or "Babbit's potash." Dissolve this lye in as little water as will completely dissolve it. Start with ½ pint of water, and if this will not dissolve all the lye, add more water slowly. Let this stand for at least 3 hours until the lye is completely dissolved and the solution is cold; then add the *cold* lye solution *very slowly* to the linseed oil, stirring constantly. Not less than five minutes should be taken for the adding of this solution of lye to the oil. After the lye is added continue the stirring until the mixture is in the condition and has the texture of a smooth, homogeneous liquid soap. This ought not to take more than a half hour. Then while the soap is in this liquid state, and before it has a chance to harden add, with constant stirring, 8½ quarts of commercial cresol. The cresol will blend perfectly with the soap solution and make a clear, dark brown fluid. The resulting solution of cresol soap is then ready to use. This cresol soap will mix in any proportion with water and yield a clear solution.

As has been said, cresol soap is an extremely powerful disinfectant. In the Station poultry plant for general purposes of disinfecting the houses, brooders, brooder houses, incubators, nests, and other wood work, it is usually used in a 2 per cent. solution with water. Two or three tablespoons full of the cresol soap to each gallon of water will make a satisfactory solution. This solution may be applied through any kind of spray pump or with a brush. Being a clear watery fluid it can be used in any spray pump without difficulty. For disinfecting brooders or incubators which there is reason to believe have been particularly liable to infection with the germs of white diarrhea or other diseases the cresol may be used in double the strength given above and applied with a scrub brush in addition to the spray.

Studies on Hybrid Poultry.*

When the Department of Biology of this Station was organized in the summer of 1907 a part of its work, as outlined in the original plan, involved the study of inheritance in hybrid or cross bred poultry. The general purpose with which the studies in hybrid poultry were planned was primarily to investigate fundamental principles of inheritance. During the first year of the work the experiments in this direction were largely preliminary in character. A large number of crosses were made for the purpose of getting a general view of the behavior in inheritance of some of the characters seen in the common breeds of domestic poultry. As a result of these preliminary experiments it was finally decided to undertake a thorough investigation of the reciprocal crosses of the Cornish Indian Game and Barred Plymouth Rock breeds. The detailed study of these reciprocal crosses was then begun in 1908. The present paper is a report on some of the results which have been obtained in this study up to the present time.

There were a number of reasons why this particular cross of Barred Plymouth Rock and Cornish Indian Game was chosen for detailed study. In the first place these two breeds of fowls are strikingly different from each other in a wide variety of characters. Some of the points of difference are indicated in Table 2.

The general characteristics of the two breeds crossed are shown in Figs. 75 and 76. Figure 75 gives a representation of a male and female Barred Plymouth Rock, and Fig. 76 of male and female Cornish Indian Games. Unfortunately the photographs of the Cornish fowls are not altogether satisfactory. The ruffled appearance of the feathers in the male is not characteristic, and appears in this photograph only because the wind was blowing when it was taken.

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*Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 21.

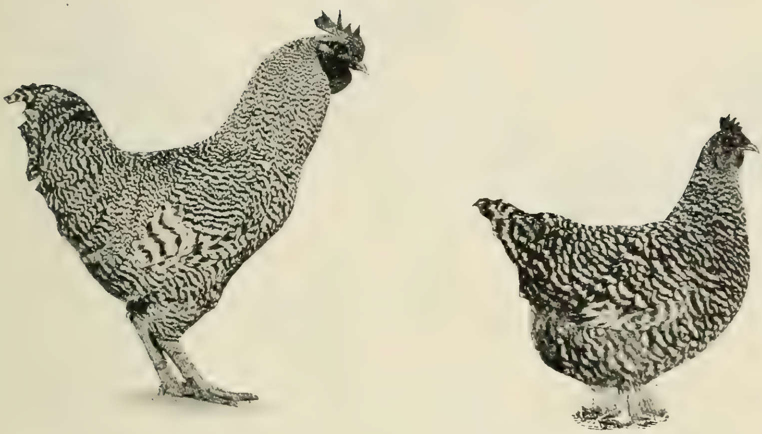

FIG. 75. Barred Plymouth Rock. Male and female.

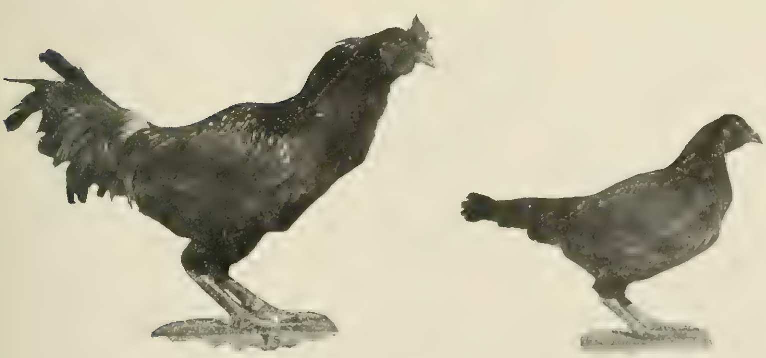

FIG. 76. Cornish Indian Game. Male and female.

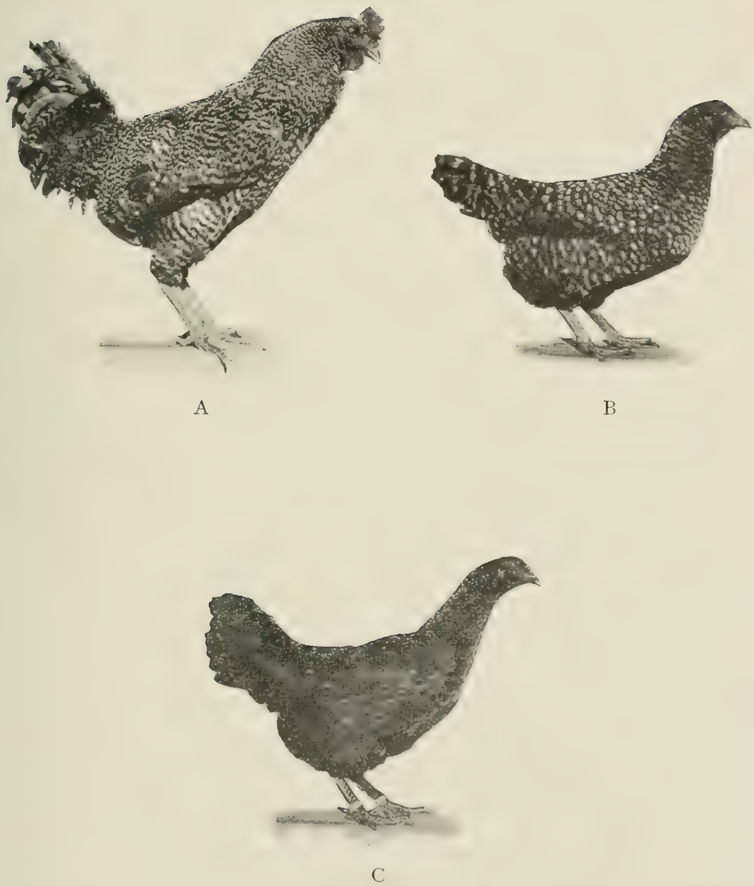

FIG. 77. Hybrids between Barred Plymouth Rocks and Cornish Indian Games. A. Male bird. The males from the cross and its reciprocal are alike in appearance. B. Barred female (from Barred Plymouth Rock male and Cornish Indian Game female). C. Black female (from Cornish Indian Game male and Barred Plymouth Rock female).

TABLE 2.

Summary Statement of Typical Condition of Characters of Barred Plymouth Rocks and Cornish Indian Games.

CHARACTER.	Condition in Barred Plymouth Rocks.	Condition in Cornish Indian Games.
Comb	Single	Pea.
Wattles	Moderately long	Very scant.
Beak	*Yellow* (sometimes marked with horn colored stripes or patches.)	*Yellow* (often marked with *brown* or horn colored stripes or patches).
Eyes	Bright *red* or *bay*	*Yellow*, or approaching pearl.
Breast	*Medium* breadth. Sternum relatively *long*. Medium amount of breast meat.	Very *broad*. Sterum relatively *short*. Large amount of breast meat.
Back	Curve from neck to tail slightly *concave*.	Curve from neck to tail slightly *convex*.
Hackle feathers	*Abundant*. falling well over the shoulders and giving the neck a full appearance.	Rather *short* and *closely set*, giving the neck a neat, spare appearance.
Saddle feathers (in male)	Abundant and *long*	Rather *short*.
Body	Relatively *long*, and flattened in the dorsoventral plain.	Relatively *short*, and *round*. *Less* flattened.
Fluff	Moderately full	Not full. Feathers set close into body, giving it a neat "tucked up" appearance.
Shanks	Yellow, sometimes dusky or spotted with black pigment	Yellow or dusky yellow.
Plumage color	Barred in all sections. Basic pigment a bluish black or dark slate. See special description in American Standard of Perfection, pp. 205–208.	Non-barred. Basic pigments, black, red or bay, mahogany. See special description below (p. 86).
Tail	Carried relatively *high* well spread.	Carried relatively *low*. Compact.
Carriage	Less erect	More erect.
Winter egg production	*Good* Nov.–March mean, 1908–09. 26.53 ± .65.	*Poor*. Nov.–March mean, 1908–09. 14.92 ± 1.58.
Egg color	Deep reddish or pinkish brown. Greater saturation of color.	Pure yellowish brown. Less saturation of color.
Egg size	Relatively large. Pullets means: Length=56.322 ± .076 mm. Breadth=41.917 ± .044 mm. *Volume=51.880 ± .135 c. c.	Relatively small. Pullet means: Length=52.61 ± .35 mm. Breadth=40.43 ± .23 mm. *Volume=44.84 ± .86 c. c.
Egg shape	Relatively long and pointed. Mean length-breadth index for pullets=74.522 ± .120.	Relatively short and round. Mean length-breadth index for pullets=76.86 ± .30.
Chick down	*Black*, or very dark gray, with some creamy white parts	*Creamy yellow* below, with well marked mahogany or seal brown pattern on back.
Skin	Yellow and relatively thick	Yellow, and relatively thin.

*Calculated from the formula $V_{egg} = 4.1888\ (\tfrac{1}{2}\ \text{breadth})^2 \times (\tfrac{1}{2}\ \text{length})$.

The plumage color of the Cornish Indian Games requires more detailed consideration. The following description, adapted from the American Standard of Perfection (pp. 205-208) is taken from another paper.*

Color of Cornish Indian Games.

MALE.	FEMALE.
Head: Plumage black.	*Head:* Plumage black or black penciled with bay, approaching mahogany.
Neck: Hackle, glossy and greenish black; shafts red; plumage other than hackles, rich, glossy black.	*Neck:* Hackle glossy black, with bay shaft to each feather, the black greatly predominating; plumage other than hackle, ground color bay, approaching mahogany, each feather having two pencilings of lustrous black, the pencilings following contour of web of feather.
Back: Glossy greenish-black and dark red intermixed, the black greatly predominating; saddle feathers like the back in color, but with a somewhat larger proportion of dark red.	*Back, Breast, Body, Wing-Bows, Wing-Coverts* and *Tail-Coverts:* Ground color bay, approaching mahogany, each feather having two pencilings of lustrous black, the pencilings following contour of web of feather.
Breast: Rich, glossy black, free from any other color.	
Body and *Stern:* Black.	*Stern:* Black, or black tipped with bay.
Wings: Wing fronts, black; wing bows, glossy greenish-black and dark red intermixed, the black greatly predominating; coverts forming wing bars, metallic black; primaries, black, except a narrow edging of bay on outer web; secondaries, upper web black, lower web about ½ black next to shaft of feather, the remainder being bay.	*Wings:* Primaries, black, except a narrow edging of irregularly penciled bay upon outer part of web; secondaries, upper web black next to shaft of feather, with a broad margin of irregularly penciled bay.
Tail: Black; sickles and coverts, glossy greenish-black.	*Tail:* Main feathers, black or irregularly penciled with bay.

Barred Plymouth Rocks and Cornish Indian Games present two extremes from the utility standpoint. This affords another important reason why this particular cross was chosen for intensive study. The Cornish Indian Game is a "meat type" bird *par excellence.* It has long been noted as one of the best breeds of poultry for meat producing purposes, particularly when crossed with other breeds. The Plymouth Rock, on the other hand, while a general purpose fowl, has been more particularly bred for its egg producing qualities. One of the objects held in mind in undertaking the work was to see in how far it might be possible to recombine, in accordance with Mendelian principles, the utility characters of these two breeds.

The purpose of the present paper is to give an account of some of the results of this hybrid work in the F1, or first hybrid generation.

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*Pearl, R. and Surface, F. M. On the Inheritance of the Barred Color Pattern in Poultry. Roux's Archiv. (In press).

SOURCE OF BREEDING STOCK USED.

In regard to the stock used in the experiments (obviously a matter of the highest importance in all Mendelian experimentation) the following may be said: The Barred Plymouth Rock stock used was that which has been bred at this Station for many years. The general breeding history of these birds is known for a period of more than 25 years. For a period of nearly ten years before the present experiments were begun they had been "line-bred," i. e., no new "blood" had been introduced into the flock from outside. The Cornish Indian Game foundation stock was reared from eggs purchased from Mr. W. S. Templeton, of Illinois, who is conceded by American poultry fanciers generally to have a strain of Cornish fowls of a high degree of excellence. The source of this stock gives assurance that it is strictly "pure-bred" in the fancier's sense, and furthermore is of superior quality as judged by the fancier. This stock, in other words, carries the characters which belong to the breed in their *typical* condition.

THE COLOR OF THE HYBRIDS.

The inheritance of color and color pattern in these hybrids has already been discussed in detail in another paper.* It will therefore not be necessary here to do more than outline the general facts regarding color inheritance, referring the reader to the paper cited for details. The essential facts are as follows:—

When the mating is to the type

Barred Plymouth Rock male x *Cornish Indian Game female*

the offspring are *all barred,* regardless of their sex.

When, on the other hand, the mating is of the type

Cornish Indian Game male x *Barred Plymouth Rock female*

the *male* chicks resulting from the cross are *barred,* and the *female* chicks are *not barred* but instead are solid black in color.

The character of the different kinds of hybrid birds obtained is shown in Fig. 77. This shows a hybrid male and barred and black hybrid females.

The actual numbers of the different kinds of *adult* hybrid birds obtained in the experiments are given in the following table, which is condensed from the more complete tables given in the detailed paper (*loc. cit.*)

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*Pearl, R., and Surface, F. M. *loc. cit.*

TABLE 3.

Showing the Sex and Color Pattern of Hybrids Obtained by Reciprocally Crossing Barred Plymouth Rocks and Cornish Indian Games.

MATING.	Total offspring.		ADULT OFFSPRING.			
			Barred.		Non-barred; Black.	
	Male.	Female.	Male.	Female.	Male.	Female.
Barred Rock ♂ x Cornish ♀	112	111	70	68	–	–
Cornish ♂ x Barred Rock ♀	127	124	95	–	–	96
Totals	239	235	165	68	–	96

It is clear that we have here a case of sex limited inheritance, in which a character is correlated with sex in a definite manner. It was suggested some time ago by Spillman* that barred color pattern in poultry would be found to be inherited in this sex limited manner. This suggestion has been tested and, in a brief preliminary paper, confirmed by Goodale.**

A Mendelian hypothesis, which may or may not be true, has been put forth by Spillman (*loc. cit.*) to account for facts regarding the inheritance of barring given above. This hypothesis has been stated in briefest form by Goodale (*loc. cit.*) as follows: "The barring factor and sex in poultry are correlated in such a way that the female is always heterozygous in respect to sex and also barring when present. The male, on the other hand, is always homozygous in respect to sex and may be either homozygous or heterozygous in respect to barring." Further, it is assumed that "femaleness" and the barring factor do not exist together in the same gamete. This can be easily represented symbolically.

*Spillman, W. J. Barring in Barred Plymouth Rocks. Poultry, Vol. 5, No. 11, August, 1909, pp. 7, 8.

——— Spurious Allelomorphism; Results of Some Recent Investigations. Amer. Nat. Vol. XLII, pp. 610-615, 1909.

**Goodale, H. D. Sex and its Relation to the Barring Factor in Poultry. Science, N. S., Vol. 29, No. 756, pp. 1104, 1105. 1909.

Let F denote "femaleness," i. e., the ♀ sex character.

Let f denote absence of F (i. e., "maleness" by difference, as it were).

Let B denote the barring factor.

Let b denote the absence of B.

Then	a	pure	B. P. R. ♂	has	the	gametic	formula	Bf . Bf
and	"	"	B. P. R. ♀	"	"	"	"	bF . Bf
"	"	"	C. I. G. ♂	"	"	"	"	bf . bf
"	"	"	C. I. G. ♀	"	"	"	"	bF . bf

Then the mating B. P. R. ♂ x C. I. G. ♀ would be symbolically

$Bf.Bf$ x $bF.bf = Bf.bf$ (barred ♂) + $Bf.bF$ (barred ♀) the offspring of both sexes being heterozygous with reference to barring.

The reciprocal mating is symbolically

$bf.bf$ x $bF.Bf = bf.Bf$ (barred ♂) + $bf.bF$ (non-barred ♀) the non-barred ♀ offspring being homogygous with regard to the absence of barring.

It is evident, without further discussion, that the experimental results set forth above are, so far as they go, precisely what we should expect to get if Spillman's hypothesis is correct. In so far they support that hypothesis. They do not, of course, demonstrate that another hypothesis might not be devised which would fit the facts equally well.

The barred pattern obtained in these hybrids is not the same as that exhibited by the parent Barred Plymouth Rock stock. A detailed description of the points in which the hybrids differ in color from the parent stock is given in the complete paper and cannot be repeated here. Some of these points of difference are shown in Fig. 78.

Sex-limited inheritance, in which a particular somatic character is correlated with sex in a definite way, is now known to occur in a number of cases. In poultry we have besides the inheritance of barring as worked out by Spillman, Goodale and the present writers, and on the other hand, the inheritance of "Bankiva" and "Brown-red" color pattern in game bantams

recently described by Hagedoorn,* the inheritance of shank color and the case of the silky fowl as described by Bateson,** etc. Bateson (*loc. cit.*) devotes a chapter in his recent book on heredity to a discussion of these known cases of sex-limited inheritance.

In the remainder of this paper the hybrid pullets will, for the sake of convenience, be designated as either "barred hybrids" or "black hybrids."

THE HATCHING, MORTALITY AND SEX OF THE HYBRIDS.

The hatching records for the matings which produced the hybrids are given in Tables 4 and 5. These data are of interest chiefly from the standpoint of the physiology of reproduction. It is well known that in many cases in plants it is possible to make a cross in one direction, while the reciprocal cross entirely fails to produce offspring. In other cases the fertility is greatly reduced in the cross in one direction as compared with the reciprocal. Is there any relation of this kind in the crosses of poultry with which this paper deals? The data in the following tables are of interest in this connection. It should be said that all of the mated females, whether Barred Rocks or Cornish, were pullets. The male birds were cockerels. All were under the same conditions during the mating season, and had the same food and treatment. The eggs were all incubated in the same type of incubators, under uniform conditions. For the sake of comparison a table (Table 6) giving the hatching records of pure Cornish Indian matings is included. In all of these tables "Percent hatched" means percent of fertile eggs hatched.

In the cross Cornish Indian Game ♂ x Barred Plymouth Rock ♀, the data for which are given in Table 4, two different males were used with the same females in the course of the breeding season. The matings with the two different cockerels are separated in the table, and each group is summed and averaged by itself.

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*Hagedoorn, A. L. Mendelian Inheritance of Sex. Roux's Archiv. Bd. 28, pp. 1-34, 1909.

**Bateson, W., Mendel's Principles of Heredity. Cambridge (Univ. Press). 1909.

TABLE 4.

Hatching Records for the Mating C. I. G. ♂ x B. P. R. ♀.

MATING NUMBER.	Eggs set.	Eggs infertile.	Percent infertile.	Died in shell.	Percent of fertile eggs dying in shell.	Hatched.	Percent hatched.	Number of different incubators.
443	51	1	2	11	22	39	78	5
444	25	1	4	10	42	14	58	3
445	49	1	2	7	15	39	81	5
446	11	0	0	2	18	9	82	2
447	12	9	75	1	33	2	66	2
448	22	13	59	5	56	4	44	3
449	23	13	57	4	40	6	60	3
451	6	1	16	2	40	3	60	1
452	10	5	50	2	40	3	60	2
458	15	10	67	2	40	3	60	2
460	27	6	22	5	24	15	72	3
461	19	6	32	4	31	8	62	3
Totals and means....	270	66	25	55	27	145	71	–
587	21	0	0	5	24	16	76	3
588	20	8	40	6	50	6	50	2
589	27	1	4	4	15	22	85	3
591	19	9	47	6	60	4	40	3
593	10	1	10	2	22	7	78	2
594	17	1	6	5	31	11	69	3
595	29	1	4	11	39	17	61	3
596	25	3	12	9	41	12	55	3
597	13	0	0	5	38	8	62	2
598	22	0	0	16	73	5	23	3
599	23	2	9	9	43	12	57	3
600	25	13	52	9	75	7	58	3
601	33	22	67	1	10	10	91	4
Totals and means....	284	61	21	88	39	137	62	–
Grand totals and means.	554	127	24	143	33	282	66	–

TABLE 5.

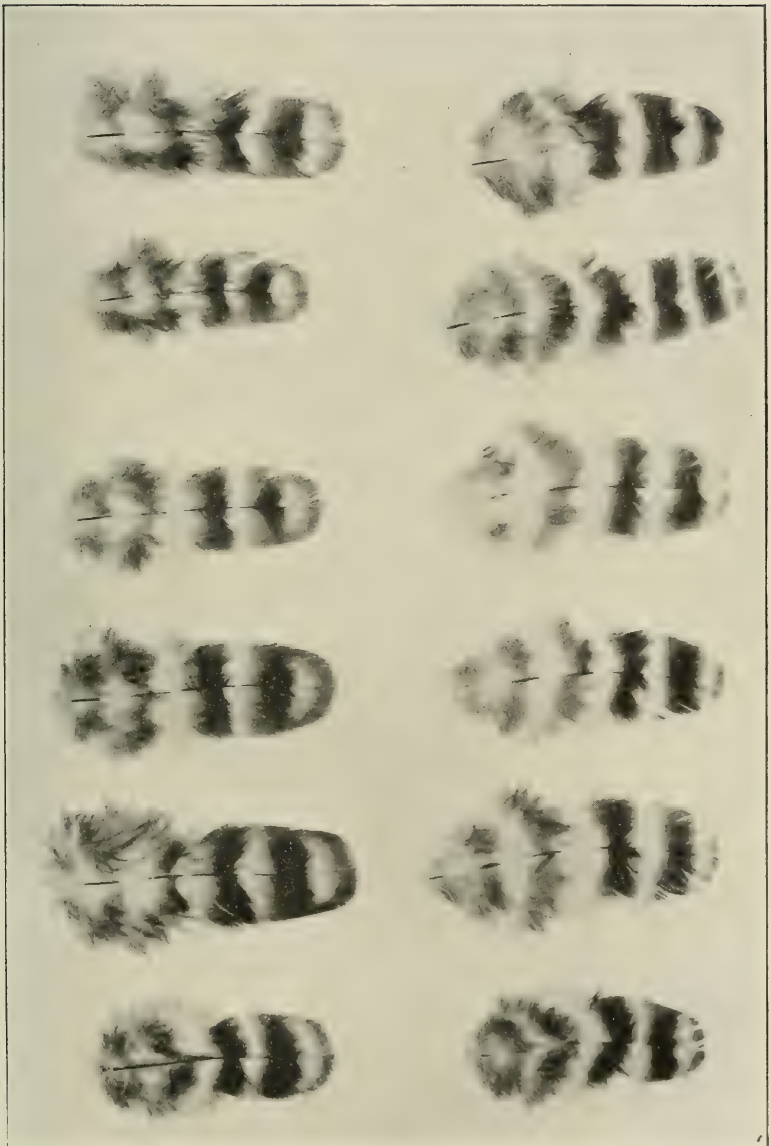
Hatching Records for the Mating B. P. R. ♂ x C. I. G. ♀.

Mating Number.	Eggs set.	Eggs infertile.	Percent infertile.	Died in shell.	Percent of fertile eggs dying in shell.	Hatched.	Percent hatched.	Number of different incubators.
418	26	0	0	10	38.0	16	62	3
419	25	1	4	5	21.0	17	71	2
420	18	1	6	13	76.0	4	24	3
421	31	2	6	12	29.0	17	59	2
422	37	0	0	6	16.0	31	84	5
423	33	0	0	14	42.0	19	58	4
424	52	7	13	4	9.0	39	87	6
425	23	0	0	6	26.0	17	74	3
426	24	0	0	5	21.0	19	79	3
427	22	0	0	2	9.0	20	91	3
428	46	2	4	10	23.0	34	77	5
429	20	1	5	3	16.0	16	84	3
Totals and means	357	14	4	90	26.0	249	73	–

TABLE 6.

Hatching Records for Pure Cornish Indian Game Matings. (C. I. G. ♂ x C. I. G. ♀).

Mating Number.	Eggs set.	Eggs infertile.	Percent infertile.	Died in shell.	Percent of fertile eggs dying in shell.	Hatched.	Percent hatched.	Number of different incubators.
430	32	1	3	4	13	27	87	5
431	19	2	11	4	24	12	71	4
432	46	2	4	23	52	21	48	3
433	32	1	3	9	29	22	71	3
434	48	2	4	10	22	36	78	4
435	35	2	6	9	27	24	73	3
436	26	0	0	6	23	20	77	3
437	45	8	18	36	97	1	3	3
438	23	3	13	5	25	15	75	3
439	54	9	17	40	89	5	11	4
440	19	7	37	6	50	6	50	3
567	38	4	11	15	44	19	55	4
Totals and means	417	41	10	167	44	208	55	–



A B

FIG. 78. Feather Chart, showing feathers from Barred Rock female and Barred hybrid female. A. feathers from hybrids. B. feathers from Barred Rocks.

From these tables the following points are to be noted:—

1. The fertility of the eggs during the hatching season in which these hybrids were raised was relatively very high for the pure bred birds, both Barred Plymouth Rocks and Cornish Indian Games. The average percentage of eggs infertile from all the Barred Plymouth Rock pullets used as breeders during that breeding season was 13.65 ± 1.38.* The average percentage of eggs infertile for the pure Cornish Indian Game matings shown in Table 6 above is only 10. In both cases (Barred Rocks and Cornish) the figures given include all the eggs set throughout the whole of the hatching season from early in March until the middle of May. No data were omitted in making up these general averages. It is evident from these average figures of 13 percent and 10 percent of infertile eggs that (a) the environmental conditions were favorable for securing high fertility of eggs during the hatching season of 1909 and (b) that the breeding stock of both pure breeds was vigorous and in good condition. It is doubtful whether fertility records sensibly lower than 10 percent of infertile eggs for the whole hatching season can be expected with large flocks of birds.

2. It will be noted from Tables 4 and 5 that the percentage of eggs infertile in the hybrids was quite different according to the direction in which the cross was made. In the case of the cross considered in Table 5 (Barred Rock ♂ x Cornish ♀) the percentage of eggs infertile is very low, amounting to only 4 percent for the whole season. This, it will be noted, is a better average result than was obtained with either the Barred Rocks or Cornish Indian Games when pure bred during the same season, and kept under the same environmental conditions throughout. On the other hand, the fertility of the eggs in the reciprocal mating (Cornish Indian ♂ x Barred Rock ♀) was very much reduced, as is shown in Table 4. Taking the whole season through and averaging the results obtained from two different male birds used in this cross the percentage of eggs infertile is 24. This is six times as great a percentage of infertility as was obtained in the other cross, and is practically twice as great as the highest percentage

*Cf. Me. Agric. Exp. Station Bulletin 168, Table VI, p. 119.

of infertility obtained from either of the pure matings of the two breeds entering into the cross during the same hatching season.

It seems unlikely that this considerable reduction in fertility of eggs in the cross Cornish ♂ x Barred Rock ♀ was due to poor quality of the male birds used. The reason for this opinion lies in the first instance in the fact that two different male Cornish birds were used and both gave almost identical results. Both were first rate specimens in all particulars so far as could be told by external appearances. They were certainly vigorous birds. This being the case it seems remarkable that both should have shown so nearly the same degree of infertility of eggs. On the other hand the result does not appear to be due to the inclusion in the pen of a number of particularly bad individual females that were incapable of making high fertility records. While in both halves of Table 4 there are individual females with extremely poor records as to fertility of eggs, it is nevertheless the fact that the birds which gave bad results with one of the cockerels are not the same ones that gave bad results with the other, as would be expected to be the case if the fault were primarily with the female birds.

A suggestion which occurs to one in this connection is that the Cornish Indian spermatozoa do not find the Barred Plymouth Rock oviduct so favorable an environment as they do the Cornish Indian oviduct. It is a well known fact that in gallinaceous birds the spermatozoa from one copulation fertilize a number of eggs. In order that this may occur the spermatozoa must live and remain in vigorous condition in the oviduct of the female for a considerable period of time. In the present instance there may be a lowering of the vitality of the Cornish Indian spermatozoa due to a lack of adaptation to the conditions presented by the Barred Rock oviduct. The significant factors in such a case would probably be of a chemical character. It is conceivable that the secretion of the Barred Rock oviduct may be too acid or too alkaline to give the best results for the Cornish Indian spermatozoa. Obviously the present data are not sufficiently extensive to give any conclusive evidence in regard to this suggestion. The great difference in the fertility of eggs in the crosses made in the two different directions is, however, of interest and deserves further investigation.

3. Turning now to the consideration of the hatching quality of the eggs in the two different crosses, it appears to be the case in the present statistics that the *fertile* eggs of either Barred Plymouth Rock or Cornish Indian Game females are more likely to *hatch* if they are fertilized with spermatozoa of the other breed than if they are fertilized with their own spermatozoa. That is to say, in these experiments the percentage of fertile eggs hatched was higher for the cross fertilized eggs than for either of the pure breeds under the same environmental conditions, regardless of the direction of the cross. The data in the case are as follows: For the Barred Plymouth Rock pullets in the whole breeding season of 1909, the average percentage of fertile eggs hatched was 47.67 ± 1.80.* The pure matings of Cornish Indian Games in the same season gave an average of 55 percent of fertile eggs hatched, as shown in Table 6. For the hybrids, as shown in Tables 4 and 5, the average figures of the whole season are 73 percent of fertile eggs hatched for the cross in one direction (Barred Plymouth Rock ♂ x Cornish Indian Game ♀) and 66 percent of fertile eggs hatched in the reciprocal cross. In other words, the *hybrid* germ cell (fertilized ovum) appears to possess greater developmental vigor than does the *pure* germ cell. This is shown not only in the greater viability of the eggs during incubation, but also in other ways. These hatching records, however, furnish a novel kind of evidence of the well known phenomenon of greater vigor in hybrids.

4. The "percentage of fertile eggs dying in the shell" is obviously the arithmetic complement of the "percentage of fertile eggs hatched" and does not need particular discussion.

We may turn next to a consideration of the mortality and sex ratio records. The data for all hybrid chickens hatched in the whole season are given in Table 7, while the data for all chickens hatched in the season for pure matings are in Table 8. In order to save space detailed data for each individual mating are not given in the case of the pure bred chicks.

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*Cf. Me. Agr. Exp. Sta. Bulletin 168, Table VI, p. 119.

TABLE 7.

Showing the Sex Ratio and Mortality Records of All Hybrid Chicks. Season of 1909.

BARRED ROCK ♂ x CORNISH ♀.

Mating number.	Total chicks. ♂	Total chicks. ♀	Chicks died. ♂	Chicks died. ♀	Percentage mortality. ♂	Percentage mortality. ♀
418	5	9	4	6	80	67
419	5	9	2	2	40	22
420	2	0	0	0	0	0
421	8	7	0	1	0	14
422	15	15	6	5	40	33
423	6	12	2	2	33	17
424	20	16	8	4	40	25
425	9	6	2	0	22	0
426	8	10	3	4	38	40
427	11	7	4	5	36	71
428	14	16	12	12	86	75
429	9	4	5	3	56	80
Grand totals.	112	111	48	44	43	40

CORNISH ♂ x BARRED ROCK ♀.

Mating number.	Total chicks. ♂	Total chicks. ♀	Chicks died. ♂	Chicks died. ♀	Percentage mortality. ♂	Percentage mortality. ♀
443..........	19	14	10	7	53	50
444..........	6	6	0	2	0	33
445..........	16	19	5	5	31	26
446..........	3	5	0	0	0	0
447..........	2	0	0	0	0	0
448..........	2	2	1	1	50	50
449..........	3	3	0	0	0	0
451..........	2	1	0	0	0	0
452..........	2	1	0	0	0	0
458..........	0	3	0	0	0	0
460..........	9	6	0	1	0	17
461	8	0	2	0	25	0
Totals ...	72	60	18	16	25	27
587..........	4	9	1	3	25	33
588..........	1	2	1	1	100	50
589..........	11	11	0	2	0	18
591..........	1	3	1	1	100	33
593..........	4	3	0	0	0	0
594..........	2	3	1	2	50	67
595..........	6	10	1	4	17	40
596..........	6	6	2	1	33	17
597..........	2	5	0	0	0	0
598..........	2	3	1	2	50	67
599..........	7	5	2	2	29	40
600..........	2	4	1	2	50	50
601..........	7	0	3	0	43	0
Totals ...	55	64	14	20	25	31
Grand totals.	127	124	32	36	25	29

TABLE 8.

Showing the Sex Ratio and Mortality Records of All Pure Bred Chicks Hatched from Pullet Eggs. Season of 1909.

MATING.	Number of different matings.	Total chicks.		Chicks died.		Percentage mortality.	
		♂	♀	♂	♀	♂	♀
Barred Plymouth Rock ♂ and ♀ ..	111	664	698	278	238	43	34
Cornish Indian Game ♂ and ♀....	12	59	76	26	29	44	38

From these tables the following points are to be noted:

1. In both hybrid matings a few more males than females were produced. The differences, however, are so small as to be insignificant. Practically an equal absolute number of males and females were produced in the hybrid matings. In the pure matings on the other hand there is a distinct and significant preponderance of females in both matings.

2. It appears then to be the case that there is a tendency shown in the 1971 chicks here under consideration for *relatively* more males to be produced in hybrid than in pure matings. This result is in accord with a suggestion made by Davenport* in the following words (p. 97): "There is a widely held and frequently expressed opinion that hybrids show an excessive proportion of males." No support was given to this suggestion by Davenport's own published statistics. His general conclusion was that, "The exceptions to the law of equality of sexes in hybrid offspring are . . . . individual and not of general significance." It was subsequently shown* that there is an excess of males produced when certain human stocks are cross bred as compared with the same stocks bred pure.

The real test of whether the present poultry statistics definitely bear out the same conclusion must come from an examination of the probable errors of the sex ratios involved. Taking the sex ratio as the percentage of males in the total number of offspring we have the usual expression for the probable error of a proportion

*Davenport, C. B. Inheritance in Poultry. Carnegie Institution of Washington, Pbl. No. 52, 1906.

*Pearl, Maud D. and R. On the Relation of Race Crossing to the Sex Ratio. Biol. Bulletin, Vol. 15, No. 4, pp. 194-205. 1908.

$$P.\ E.\ ratio = .67449\ \sqrt{pq/n}.$$

where p = percentage of males, q = percentage of females ($= 100 - p$), and n = the total number.

Applying this formula to the data in Tables 7 and 8 we have the following results:—

Percentage of males amongst all hybrids........	50.42 ± 1.55
Percentage of males amongst all pure Barred Rocks	$48.75 \pm .91$
Percentage of males amongst all pure Cornish...	43.70 ± 2.88
Difference in proportion of males between hybrids and Barred Rocks..........................	1.67 ± 1.80
Difference in proportion of males between hybrids and Cornish	6.72 ± 3.27

It thus appears that 1 2-3 percent. more males are produced in hybrid than in pure Barred Rock matings, and 6.72 percent more than in pure Cornish matings. The probable errors are of such magnitude, however, that it cannot be asserted that these differences are significant. The data are of interest in so far as their general trend is concerned, however, and will be of value, in connection with further material to be collected in the future, in helping to settle this particular phase of the problem of sex-determination.

3. The chick mortality, both absolute and percentage, is substantially equal in the two sexes in the case of the hybrids.

4. In the case of the pure bred chicks the percentage mortality is distinctly higher for the males than for the females, in both breeds. No reason for this marked difference in the mortality rate of the sexes in pure bred birds is apparent. Nor is it clear why there is a difference between hybrid and pure bred birds in this regard. It is idle to discuss the various speculations regarding the possible cause of this relation which come to one's mind until more ample data can be had.

5. The mortality shown in Tables 7 and 8 is absolutely high. These tables give in that respect an entirely wrong impression of the general vigor and vitality of the chicks raised in the spring of 1909. The reason why the mortality figures are so high in these tables has little relation to the real quality of the chicks themselves. The high mortality originates from the results of one hatch. On April 21, 1909, a large hatch (between 600 and 700 chicks) was brought off. These chicks

were as promising looking a lot when they came from the incubators as any hatched during the season. They were a strong and vigorous flock. No one of them, so far as we know, died from an infectious disease, like white diarrhœa. Yet practically every chick in this hatch died, and that within four weeks of hatching. They were fed by a man without any previous experience in feeding Barred Rock chickens under our conditions of brooding, etc. In spite of repeated instructions the birds were over fed to the point where it became impossible to save any of them. The effect of this one hatch on the total mortality records is shown in Table 9.

TABLE 9.

Showing the Sex Ratio and Mortality Records of Chicks, with the Hatch of April 21, 1909, Omitted.

MATING.	Total chicks.		Chicks died.		Percentage mortality.	
	♂	♀	♂	♀	♂	♀
Barred Rock ♂ x Cornish ♀	88	84	31	25	35	30
Cornish ♂ x Barred Rock ♀	116	114	25	31	22	27
Barred Rock ♂ x Barred Rock ♀	506	548	90	81	18	15
Cornish ♂ x Cornish ♀	51	56	20	13	39	23

The great reduction of mortality, especially among the Plymouth Rocks, is apparent. More than a half of the total mortality of the whole season among Plymouth Rock chicks resulted from this one hatch.

6. Taking the corrected figures of Table 9 as a basis it appears to be the case (a) that hybrid chicks from Cornish eggs (mating B. P. R. ♂ x C. I. G. ♀) showed about the same percentage mortality as pure Cornish chicks; and (b) that hybrid chicks from Barred Rock eggs (mating C. I. G. ♂ x B. P. R. ♀) showed about the same percentage mortality as pure Barred Rock chicks; and (c) that the mortality of all chicks whether from hybrid or pure Cornish eggs was greater than that of all chicks of corresponding matings from Barred Rock eggs. The uncorrected figures of Tables 7 and 8 show the same general trend, though with some differences in detail as is to be expected.

WINTER EGG PRODUCTION IN THE HYBRID AND PURE BRED PULLETS.

The egg production of these hybrid birds in comparison with the pure bred stock is a matter of a great deal of interest. The two breeds crossed differ very markedly in their innate productive capacities. One has good egg production and the other poor egg production as definite and fixed breed characters. In the hybrids is afforded an opportunity to test the question of whether egg production is inherited as a definitely segregable character. To settle this question is a very important matter in connection with the whole problem of breeding for egg production.

In order to get results which shall be in any way reliable in a study of this kind certain conditions have been found in the long experience at this Station in the study of egg production to be of fundamental significance. The most important of these are:

(1) A relatively large number of birds must be trap nested to secure reliable results. Comparisons of egg production based on returns from 5 to 10 birds can only lead to indefinite and uncertain results. Egg production is a character which shows wide fluctuating variability. This condition demands reasonably large numbers of birds, in order to determine the variation constants.

(2) The material must be biologically homogeneous. Lumping together the egg production of several small flocks may give entirely fallacious results.

(3) Environmental conditions must be the same for all birds and average age must be the same.

(4) To get reliable results regarding the inheritance of productivity, experience here has shown most clearly that the environmental conditions (housing, feed, management, etc.) must be *favorable* to good egg production. In other words, something more than simple uniformity of environment is demanded to get reliable results. Only under favorable conditions can the birds bring to full expression their innate laying capacities, whatever they may be. Under unfavorable conditions the interpretation of results must always be uncertain, because it is impossible to say how far an observed result is due to innate and how far to environmental factors. In this same connection it

is of the highest importance to have as a control a flock of birds whose production over a long period of time and under different circumstances is known. The 11 years continuous trap nest records which we have here for the Barred Rock birds is a very important help in work like the present.

(5) The egg production of the winter period (November 1 to March 1) of the laying year, furnishes practically the only data of any use in discussing the problem of the inheritance of production. This period represents a natural unit in the reproductive cycle in the bird's life. Practically nothing is to be gained by studying the production of other periods of the laying year, so far at least as problems of inheritance and breeding of egg productivity are concerned.* The only exception to this statement is with regard to the fall (September 1 to November 1) production of the pullet year. This is, in the laying cycle, a kind of "pre-winter" period. Its production is an artificial result of breeding and domestication in the same way that the winter production is.

The raw data for the winter egg production of the different hybrids and pure bred birds are given in Table 10. This table shows the frequency distributions of egg production.

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*Cf. for discussion of this matter, Pearl, R., and Surface, F. M. A Biometrical Study of Egg Production in the Domestic Fowl. II. The Seasonal Distribution of Egg Production. U. S. Dept. Agr. Bur. of Anim. Indus. Bulletin 110, Part II. In press.

TABLE 10.

Frequency Distribution of Winter (Nov. 1-Mar. 1) Egg Production for Pullets Hatched in 1909.

Eggs Laid in the Winter Period.	Number of Birds Laying the Specified Number of Eggs.				
	Mating: Barred Rock ♂ × Cornish ♀.	Mating: Cornish ♂ × Barred Rock ♀.	Mating: Barred Rock ♂ × Barred Rock ♀.	Mating: Corning ♂ × Cornish ♀ 1909 hatched.	Mating: Cornish ♂ × Cornish ♀ 1908 hatched.
0–2.9	3	12	22	4	5
3–5.9	2	5	6	5	4
6–8.9	2	6	14	4	1
9–11.9	2	8	7	1	1
12–14.9	2	8	7	2	2
15–17.9	2	7	9	–	1
18–20.9	4	2	13	2	1
21–23.9	3	4	21	–	2
24–26.9	–	4	13	–	1
27–29.9	1	6	22	–	5
30–32.9	2	–	22	–	–
33–35.9	3	3	17	–	1
36–38.9	2	–	16	1	1
39–41.9	4	–	14	–	–
42–44.9	1	3	16	–	–
45–47.9	1	4	12	–	–
48–50.9	1	1	17	–	–
51–53.9	1	–	16	–	–
54–56.9	4	–	5	–	–
57–59.9	3	1	9	–	–
60–62.9	–	1	7	–	–
63–65.9	–	1	5	–	–
66–68.9	1	–	2	–	–
69–71.9	–	–	1	–	–
72–74.9	–	–	1	–	–
75–77.9	–	–	–	–	–
78–80.9	–	–	–	–	–
81–83.9	–	–	1	–	–
Totals	44	76	295	19	25

The constants of variation calculated from these data are given in Table 11.

TABLE 11.

Constants of Variation in Egg Production in Hybrid and Pure Bred Pullets.

MATING.	Mean.	Standard deviation.	Coefficient of variation.
Barred Rock ♂ x Cornish ♀	30.55 ± 1.90	18.72 ± 1.35	61.29 ± 5.83
Cornish ♂ x Barred Rock ♀	19.07 ± 1.23	15.83 ± 0.87	83.05 ± 7.01
Barred Rock ♂ x Barred Rock ♀	32.09 ± 0.70	17.74 ± 0.49	55.28 ± 1.93
Cornish ♂ x Cornish ♀ 1909	9.08 ± 1.33	8.62 ± 0.94	94.91 ± 7.38
Cornish ♂ x Cornish ♀ 1908	15.66 ± 1.59	11.77 ± 1.12	75.18 ± 10.47

From these tables the following points are to be noted:

1. There is a very marked difference between the pullets of the two pure breeds in winter egg production in the present year. This difference is greater in 1909-10 than in 1908-09 (Cf. table 2, page 85). The chief reason is that in 1908 there were a few exceptionally high winter layers, for that breed, among the Cornish. The 1909-10 winter production average for the Cornish probably represents nearer the true breed average than the 1908-09. Furthermore the Barred Rocks at the Station were in 1907, when the present writers began breeding them, in very poor condition as regards egg production, owing to a variety of circumstances not necessary to discuss here. In 1908-09, while there was an improvement of about 7 eggs in the average winter production over 1907, they were still considerably below the normal average winter production of the strain. This normal average winter (November 1-March 1) production, determined from 8 consecutive years of trapnesting, is for the Station Barred Rock stock 36 eggs. In 1909-10 the winter production of the Barred Rocks is approaching this average reasonably closely.

2. Since all birds were kept under the same environmental conditions as to housing, feed, management, etc., and all these conditions were favorable to good egg production, the differences in the winter production in 1909-10 between pure Barred Rocks and pure Cornish are to be considered as innate, breed

differences. These differences consist of (a) a markedly lower mean winter production in the Cornish than in the Barred Rocks and (b) a markedly greater relative variability as measured by the coefficient of variation in winter egg production in the Cornish.

3. The hybrid pullets are seen to fall into two distinct classes in respect to egg production. The barred hybrid pullets coming from the mating Barred Rock ♂ x Cornish ♀ are good winter layers, having about the same mean production as the pure Barred Rocks. The black hybrids, on the other hand, which come from the mating Cornish ♂ x Barred Rock ♀ are relatively poor layers, with a mean winter production more than 11 eggs lower than that of the barred hybrids. In other words, the hybrid pullets whose *mothers* were *good* layers are themselves *poor* layers, while those whose *mothers* were *poor* layers are themselves *good* layers. Could any more striking evidence be adduced to show that the egg record of the mother, in and of itself alone, is a poor indication of what her daughter is likely to lay? Furthermore, the barred hybrids show about the same degree of relative variability in egg production as the pure Barred Rocks, whereas the black hybrids show a much higher relative variability, comparable with that of the Cornish.

These results stated under paragraph 3 are very clear cut and definite, as a study of tables 10 and 11 will demonstrate. They are of much interest, both theoretical and practical. They show that winter egg producing ability is inherited in these hybrids in a manner essentially like that in which the barred plumage pattern is inherited, as described above (pp. 87-89). The behavior of egg productivity in these hybrids is precisely of the kind we should expect to get if it were a "unit character" (i. e., a definitely segregable character) in the Mendelian sense. The facts in hand suggest, though of course they do not prove, that egg productivity is inherited in a sex limited manner, as is barring and shank color (cf. pp. 87 and 107).

The results respecting egg production in these hybrids suggest the Mendelian interpretation given below. Before detailing this particular interpretation it is desired to set forth our position regarding such interpretations in general. It is our opinion, subject of course to modification in the light of compelling facts if such appear, that the purely morphological conception of inheritance which is implied in much of Weisman-

nian and Mendelian theory rests on a very, very slight foundation of objective evidence in the first place, and in the second place has an exceedingly pernicious tendency to obscure or belittle the importance of the fact that inheritance is primarily and fundamentally a physiological *process*. In regard to this matter we are in entire accord with the *general viewpoint* respecting development and inheritance recently so distinctly and forcibly set forth by Lillie* and Riddle.**

The hypothesis here developed is made for strictly utilitarian purposes, and *without any theoretical implication whatever as to the mechanism by which the results symbolized are physiologically brought about.* Indeed these "gametic" formulæ are looked upon by the writers as simply formulæ of symbolic logic. They lead to certain expectations for each generation. Are these expectations fulfilled? If so, the formulæ have served the highly useful and scientific purpose of having predicted the future course of natural events, and may be used in the future to do the same thing again. If they are successful in these predictions there must exist a biological reason why this is so. To determine this reason is a problem for experimental investigation.

Let us consider the three characters (a) barred color pattern, (b) sex and (c) winter laying capacity, denoting the condition of the organism with reference to these characters by the following scheme.

B = barred color pattern present.	b = barred pattern absent, i. e., a non-barred bird.
F = female sex.	f = male sex.
L = Good winter egg production.	l = very poor winter egg production.

Then assume that the breeds crossed in these experiments are constituted as follows with reference to these three characters.

$BfL \, . \, BfL$ = Barred Rock ♂—a barred bird carrying good laying qualities, homozygous with reference to all three characters.

*Lillie, F. R. The Theory of Individual Development. Pop. Sci. Monthly. Sept. 1909, pp. 239-252.

**Riddle, O. Our Knowledge of Malanin Color Formation and its Bearing on the Mendelian Description of Heredity. Biol. Bulletin, Vol. XVI, pp. 316-351, 1909.

BfL . bFl = Barred Rock ♀—a barred bird carrying good laying qualities, but heterozygous with reference to all three characters, and with good laying associated gametically (or reproductively if one prefers) with the barred pattern.

bfl . bfl = Cornish ♂—a non-barred bird, carrying poor laying qualities, and homozygous in regard to all characters

bFl . bfl = Cornish ♀—a non-barred bird, carrying poor laying qualities, and homozygous in regard to barring and egg production, heterozygous in respect to sex.

We have then for the first cross of a Barred Rock ♂ with Cornish Indian ♀ the following expectation:

BfL . BfL x *bFl . bfl* = *BfL . bfl* = barred male birds heterozygous in respect to all characters except sex,

+ *BfL . bFl* = barred females which are good layers. This is, as a matter of fact, what we get experimentally.

For the reciprocal cross we have:

bfl. bfl x *BfL . bFl* = *bfl . BfL* = male birds precisely like those from the other cross. This is what is obtained experimentally, at least so far as external characters are concerned.

+ *bfl . bFl* = non-barred females which are poor layers. This is what is obtained experimentally.

So far as the F_1 generation is concerned the above symbolic development and the experimental facts are in entire accord. The interesting and important point now is: will the expectations deduced from the continued development of the symbolic theory for the F_2 generation be experimentally realized? The answer to this question we hope to be able to report a year from this time.

Inheritance of Shank Color.

The shank color of these hybrids furnishes another instance of sex-limited inheritance, such as has already been described for plumage color (cf. pp. 87-89 *supra*). The evidence for a sex-determined segregation of characters in the F_1 generation is just as definite and convincing in the case of shank color as it has been in plumage color. It has already been suggested by Bateson (*loc. cit.*) that shank color in fowls in general shows a tendency towards sex limitation in its inheritance. Thus he says (*loc. cit.* p. 186): "From many signs we know that there exists some complex relation between the colour of the shanks in fowls generally, and sexual differentiation. Some years ago we described a case of this kind in which the Indian Game ♀ x White Leghorn ♂ always gave F_1 yellow-shanked like both the parent breeds. But White Leghorn ♀ x Indian Game ♂ gave cocks yellow-shanked like the parents, while the hens came with a good deal of pigment in the shanks ranging to nearly a full black.

Another case illustrating this relationship between sex and shank-colour is to be seen in the newly made breed called Black Leghorn. According to the fanciers' ideal both sexes should have full yellow shanks. There is no difficulty in getting this quality in the cocks, but hitherto clear yellow-shanked hens have been very rare, and the same difficulty is encountered in breeding Black Wyandottes."

As is indicated in Table 2 (page 85) both Cornish Indian Game and Barred Plymouth Rock are yellow-shanked breeds. The facts as to the distribution of shank color in the F_1 hybrids are shown in the following table.

Table 12.

Showing the Shank Color of F_1 Hybrids.

Mating.	Shanks of males.	Shanks of females.
Barred Rock ♂ x Cornish ♀	Yellow	Yellow.
Cornish ♂ Barred Rock ♀	Yellow	Black.

The data are seen to parallel exactly those for the inheritance of barring. In the mating in one direction all the offspring are yellow-shanked, whereas in the reciprocal cross the males

come yellow-shanked and the females black-shanked. The females which have the black shanks are the birds which are solid black in plumage color (cf. p. 88).

There is, as would be expected, some variation in the intensity of the black pigmentatioin of the shanks in these hybrids. The color ranges from a very dark bottle green in some cases where the normal yellow is mixed with a relatively small amount of black pigment to an intense coal black in other specimens. In no single specimen would there be any question about classifying the bird as black-shanked. The shanks are *evenly pigmented* with the black pigment, and it is sufficient in amount to give them in superficial examination always a black coloration. *Spots* of black pigment occur more or less frequently on the shanks of the normally yellow-shanked breeds like Barred Rock and Cornish Indian Game. The black coloration of the shanks of these hybrids, however, is of a totally different order. As has been said the pigmentation in the hybrid is evenly distributed over the whole shank.

The coloration of the beak is apparently correlated with the coloration of the shanks. A table exactly like that given above for the inheritance of shank color in the F_1 generation could also be made out for the inheritance of beak color. It appears to be the case that these two portions of the body are correlated quite perfectly with respect to their coloration.

THE DOWN COLOR OF THE HYBRID CHICKS.

As indicated in Table 2 (page 85) the first chick down is normally quite differently colored in the two breeds which were used in these hybridization experiments. The normal down color of the Plymouth Rock chick when just hatched is a dark gray to black with creamery white markings, the belly always being white. The Cornish Indian Game chicks have a beautiful cream colored down with a distinct mahogany or brown pattern on the back. The main feature of this pattern consists of two longitudinal stripes. In the first hybrid generation resulting from crossing these two breeds the down color of the great majority of chicks is uniformly black. The color is a more intense black than that seen in the Plymouth Rock chicks. There is ordinarily no white down whatever on these hybrid chicks. There may, however, be an occasional indi-

vidual varying from the pure and uniform black slightly. One hybrid chick showed to some extent the Game down pattern. A little of the down, particularly in the head region, is in some individual hybrids a very dark red.. So far as our observations extend the down color of the chicks is the same regardless of the direction of the cross. The just hatched chicks are not distinguishable in the cross and its reciprocal. The distinction in plumage color between the pullets of the two crosses does not appear until after the birds are feathered out.

If one were anxious to put these results into strictly Mendelian terminology, it might perhaps be said that the Barred Rock chick down condition is dominant over the condition of the down in the Cornish Indian Game. This, however, does not give a fair representation of the actual facts. These facts are, as has been indicated above, that the hybrid chicks are different in appearance when just hatched from either pure Plymouth Rock or pure Cornish Indian chicks. They do not show the down pattern of either breed and furthermore their degree of pigmentation is more intense than that of either breed. In a mixed lot of chickens consisting of pure Barred Rocks and hybrids there is never any difficulty on the part of an experienced person in picking out at once the hybrid chicks frim the Barred Rocks. In other words, here just as in so many other cases, the heterozygotes are recognizable as such by their somatic characteristics.,

THE INHERITANCE OF COMB FORM.

In the hybrids here discussed we have the results of crossing two distinct comb types, as already indicated in Table 2. The Barred Plymouth Rocks have a typical single comb and the Cornish Indian Games have a typical pea comb. With the rediscovery of Mendel's law of inheritance in 1900 one of the first characters to receive investigation was the comb form of domestic fowls. The cross between single and pea comb has been studied by several investigators in the hybrids between a number of different breeds of poultry. In his latest work on the subject, Bateson (*loc. cit.* p. 62) has the following to say regarding the inheritance in this cross of single by pea: "The F_1 from pea by single is pea, that character manifesting a definite dominance. The heterozygous pea combs are generally

higher than the pure pea and may usually, though not always, be distinguished from them. Sometimes the heterozygous pea comb is so large and has the ridges so ill-defined that it approaches the single type, but combs which cannot at once be referred to one class or the other are extremely rare. The distinction is especially sharp in the case of newly hatched chicks, becoming somewhat less marked with later development. F_2 from this cross is of the usual form, three pea: one single."

While, in a general way, the present investigation may be said to confirm the above statement, yet such a statement does not appear to us to give an entirely adequate view of the facts.

In the first place, so far at least as the experimental work at this Station is concerned, involving as it has excellent breeding stock on both sides, the *definiteness* of the dominance of pea over single comb in the first generation hybrids does not impress one. On the contrary there can be no doubt that if a competent poultryman, thoroughly acquainted with the fancy points of poultry, were to go through a large flock of these hybrids as they run on the range he would say that the cross of pea by single, at least as represented with Cornish Indian Games and Barred Plymouth Rocks, results in giving every intermediate condition of comb between perfect pea and perfect single. The number of pea combs obtained in these hybrids which were perfect from the fanciers' standpoint was exceedingly small. Unfortunately it is not possible to measure or to define very precisely the characteristics of these intermediate combs. In taking notes on the birds on the range the only record regarding combs which it was practically feasible to take was that they were either single, intermediate or pea. The attempt was made in every case to indicate in the record whether an intermediate comb was nearer to the single or to the pea type.

The essential results regarding comb inheritance as they appear from the present work may best be set forth as follows:

1. The number of perfect or approximately perfect pea combs, considered from the show-room or fancier's standpoint, which are obtained in these hybrids differs according to the direction of the cross. In the mating Cornish ♂ x Barred Plymouth Rock ♀ a much larger number of relatively good pea combs was obtained than in the reciprocal cross. This was

true for both of the Cornish Indian males which were used in these breeding experiments. It was also true regardless of the females. That is to say, some good pea combs, from the show-room standpoint, were obtained from practically all of the Barred Rock females.

2. The quality from the fancier's standpoint, of the pea comb obtained in the hybrids, depends in some degree on the character of the individual birds used. While, as has already been said, nearly every family of the cross in one direction will yield some individuals with relatively good pea combs, yet it is also a fact that the proportion of relatively good pea combs is very much higher in some families than in others. In certain of the matings all of the intermediate combs are very close to the perfect pea type, whereas in other individual families all of the intermediate combs are much closer to the single comb type. This factor of the individuality of the specimens bred in the determination of the precise condition of bodily characters displayed by the hybrids has been very little taken into account in Mendelian work so far done with poultry. That it is really a very important factor no one who has had experience in the practical breeding of fancy poultry has any doubt whatever.

3. The range of variation from absolutely perfect single combs, on the one hand, to perfect pea combs, on the other hand, is filled without break or gap by small intermediate gradations in comb condition in these hybrids. The occurrence of perfect single combs in the F_1 generation from a cross of pea by single came as a surprise. There can be no doubt, however, of the objective fact. Such combs occur much more frequently in the mating Barred Plymouth Rock ♂ x Cornish Indian Game ♀ than in the reciprocal cross.

The thought is, of course, at once suggested that the reason for the occurrence of these single combs was that we were dealing with a heterozygous individual bearing a pea comb in the original supposedly pure stock. As a matter of fact only one of the hybrid families from which single-combed birds were obtained shows that it is probably of this character. When homozygous single comb is crossed with heterozygous pea comb the expectation is that half of the progeny will bear pea combs and half will bear single combs. In the one family where we

were apparently dealing with a heterozygote individual in regard to comb the figures were as follows:—Mating 426 produced 11 adult offspring distributed as to comb condition as follows: Males, 2 perfect single, 2 intermediate, 1 perfect pea; females, 3 perfect single, 2 intermediate and 1 pea. Putting the intermediate and pea together as showing he pea characteristic in some degree, we have for the total 5 perfect singles and 5 peas or intermediate peas produced in this family. This is in exact accord with Mendelian expectation on the supposition that in this family we are dealing with a heterozygous Cornish Indian Game female as the mother. Whether this is the true explanation of the occurrence of single combs in this family is not, of course, absolutely certain.

The character of the single combs obtained in this family is shown in Fig. 79.

Fig. 79. Photograph of head of hybrid ♂ showing perfect single comb.

The explanation of the occurrence of single combs through a heterozygous condition of one parent by no means holds for all matings where such combs were obtained. In the other matings producing single combs besides 426 there would usually be only one or two single-combed birds out of a family of 10 to 20 peas or intermediates.

4. Detailed data regarding the condition of the comb in these hybrids may next be considered. From the three matings, 420, 422, and 587, there was obtained one perfect single-combed offspring in each case. All of the other offspring of these matings had either perfect or intermediate pea combs. From matings 419, 421, 424, 428, 429, 443, 445, 461 and 589, there were recorded one or more combs in each case as "nearly

single" or "thickened single" or "single in front and thickened behind." In all of these cases the remaining chickens in the same families had either perfect or intermediate pea combs, distinctly bearing in each case the pea characteristics. The total number of offspring in each of these cases may be obtained from Tables 4 and 5 (pages 91-92). All combs recorded as "thickened single" or "almost single" bore no trace whatever of definite lateral ridges such as are characteristic of a pea comb. These combs were single in the important respect that they lacked those parts which make a comb pea. They were not perfect single combs, however, from the fancier's standpoint. They were in almost every case too thick to be recorded as perfect single combs.

5. It is not intended to convey the idea in what has been said above regarding comb inheritance in these hybrids that the hybrid individuals bearing intermediate or single combs will not behave in subsequent breeding essentially like those having more perfect pea combs. This is a matter only to be settled by experimental investigation. The points which it is desired to bring out, with as much emphasis as possible, are (a) that there is no definite and perfect dominance of pea over single comb in these F_1 hybrids; but, (b) that, on the contrary, the F_1 birds, which are heterozygotes, show objectively in regard to comb form a perfectly graded series of comb types, ranging from the perfect single to the perfect pea condition. These facts, however, relate only to the somatic condition of the hybrids. All evidence obtained from the experimental study of inheritance during recent years agrees in indicating that the particular somatic condition of a character is an exceedingly unreliable criterion of the probable behavior in breeding of the individual organism with reference to that character. There is every reason to suppose that this is true with reference to comb inheritance.

6. It is evident that the facts set forth in this section lend themselves very readily to interpretation according to the principle of the imperfection of dominance, lately so fully developed by Davenport* to account for the inheritance of a number

*Davenport, C. B. Inheritance of Characteristics in Domestic Fowl. Carnegie Inst. of Washington. Publ. No. 121, pp. iii + 100. 12 plates, 1910.

of characteristics in poultry. We have not as yet, however, been able to convince ourselves that any real gain is made by such interpretation. We prefer rather to await the collection of a larger bulk of facts before attempting any physiological interpretation of them.

INHERITANCE OF SHAPE OF BODY.

As has been pointed out above in the general descriptions of the two breeds crossed in these experiments, there is a wide distinction between them in regard to shape of body and characteristic carriage. The Plymouth Rock is typical of the American class of birds, whereas the Cornish Indian has a typical game shape, with the characteristic uprightness of carriage in the males that is associated with game breeds. In the hybrids we note the following facts in regard to the inheritance of this character, shape of body. The inheritance here is again definitely related to sex.

1. The male hybrids, regardless of the direction of the cross, are all alike in possessing the characteristic shape of the Cornish Indian Game. They show no trace of the shape of body or carriage which is characteristic of the Barred Plymouth Rock males.

2. The female hybrids, on the other hand, are not so distinctly game-like in their characteristics. On the contrary, there appears here to be an intermediate condition between what is normally found in the two pure breeds. The hybrid pullets are distinctly intermediate in respect to shape of body.

3. There appears also to be some difference here in the result according to the direction in which the cross is made. The barred hybrid pullets as a class conform somewhat more closely to the shape of a pure Barred Plymouth Rock female than do the black hybrids. The black hybrid pullets are nearer to the Game standard of body shape.

SUMMARY.

Certain results in the first hybrid generation of reciprocally crossing Barred Plymouth Rocks and Cornish Indian Games are discussed. At the outstart the characteristics of these two breeds are described. The following points regarding the hybrids are noted:—

1. The barred color pattern is found to be inherited in a sex-limited fashion, equivalent to a phenomenon of segregation in the F_1 generation.

2. The percentage fertility of eggs is found to be much higher when the cross is made in one direction (B. P. R. ♂ x C. I. G. ♀) than in the reciprocal.

3. The hatching quality of the fertile eggs is not found to be greatly different in the cross and its reciprocal. In both cases, however, the hybrid matings gave a much higher average percentage of fertile eggs hatched than did the pure matings.

4. Study of the sex ratios indicates that proportionally more males were produced among the hybrid chicks than among those from pure matings. The difference in the sex ratios cannot, however, be regarded as significant in comparison with their probable errors.

5. The mortality records show that the percentage mortality of hybrid chicks from Cornish mothers was about the same as that of pure Cornish chicks. Similarly the percentage mortality of hybrid chicks from Barred Rock mothers was about the same as that of pure Barred Rock chicks. The percentage mortality of all chicks whether hybrid or pure from Cornish mothers was somewhat greater than that of all chicks of corresponding matings from Barred Rock mothers.

6. The hybrid pullets fall into two distinct classes in regard to winter egg production according to the direction of the cross. Hybrid pullets from Game *mothers* are relatively *good* layers. Whereas hybrid pullets from Barred Rock mothers are relatively *poor* layers. A Mendelian discussion of this result is given.

7. Shank and beak color are shown to be inherited in a sex-limited fashion as is the barred color pattern.

8. The down color of the chicks is different in the F_1 hybrids from what it is in either of the pure breeds crossed.

9. Dominance of pea comb over single is found to be far from perfect. The hybrids show a perfectly graded series of comb types ranging from the perfect single to the perfect pea condition.

10. In shape of body the hybrid males are essentially like the pure Cornish Indian Game males. The hybrid females are intermediate in shape of body between the females of the two pure breeds crossed.

TECHNICAL STUDIES ON POULTRY ALREADY PUBLISHED.

A considerable portion of the more technical scientific work of the department of biology of the Station, which has in charge the work with poultry, is published in current biological journals, not readily accessible to the agricultural public. It is the purpose of the present section of this bulletin to give briefly the essential points brought out in certain of these technical studies which have been published during the past year.

SELECTION INDEX NUMBERS IN POULTRY BREEDING.*

It is an obvious fact that a breeder practically never wishes to improve *only* one single characteristic of the plant or animal which he is breeding. What is usually desired is to improve several characteristics at the same time. Thus, with dairy cattle, while the main object in breeding is to increase the amount and quality of the milk, other things such as constitutional vigor, breeding capacity and the like cannot be lost sight of in making the selections of breeding stock. Or in corn breeding, to take an illustration from the plant side, while one may be desirous of increasing the protein content of corn, in breeding for it he must always keep in mind the conformation of the ear, size of ear, yield and a whole series of other characteristics.

One of the special objects of the poultry breeding work at the Station is to learn how to fix superior egg production in a strain by breeding. In any poultry breeding, whatever may be the special object of the breeder, a fundamentally desirable thing is reproductive or breeding capacity in the birds. A "200-egg" hen is of very little value *as a breeder* if she is not able to produce when mated with a good male bird a fair percentage of chickens which will live.

It is very generally stated by practical poultrymen that the point on which it is most often decided whether a given commercial venture in the poultry business shall succeed or fail is the expense involved in the hatching and rearing of the chickens. The female that will produce eggs which will yield a

*This section is an abstract of a portion of the following paper by R. Pearl and F. M. Surface: "Selection Index Numbers and their Use in Breeding." American Naturalist, Vol. XLIII, No. 511, pp. 385-400, 1909.

high proportion of chickens from the eggs set, and whose chickens live through to marketable age, is an extremely desirable bird from a practical standpoint.

The fundamental selection index which we have chosen for poultry relates primarily to the breeding capacity of the female. The value of this index for a particular bird can only be determined after her breeding capacity has been tested. This poultry selection index comes into application in deciding which of the pullets that have been tested as breeders in their pullet year shall be kept over to be used as breeders in their second year of life.

The formula which has been provisionally adopted in our work as a fundamental poultry selection index is as follows:

$$I_1 = \frac{5\,(a + b)}{c + d + 1}$$

The following scheme shows the meaning of the letters in the formula:

I_1 = general or fundamental poultry selection index for an individual bird.

a = percentage of this bird's eggs which hatched.

b = percentage of eggs actually laid by this bird to the total number it was possible for her to lay between February 1 and June 1 (*i. e.*, the breeding season) of the year for which the index is calculated.

c = percentage of this bird's eggs which were infertile.

d = percentage of chicks hatched from this bird's eggs which died within three weeks from the date of hatching.

A brief discussion will make clear the reasons why these particular variables are chosen for the index and are arranged in the formula in the manner that they are. A bird's value as a breeder increases as the percentage of her fertile eggs which hatch increases. Therefore *a* should go into the numerator of the index fraction. Similarly a bird's value increases as a breeder in proportion to her egg production in the breeding season. A bird which produces few eggs during the breeding season (whatever she may have done before) *ipso facto* can not produce many chickens. Instead of using the actual egg pro-

duction in the index the relative or percentage production is used, for reasons which have been discussed in a previous publication by the present writers.*

Now in distinction to the factors so far discussed it is clear that a hen's value as a breeder decreases as the number of infertile eggs which she produces in a given time increases. To put this factor into the breeding index is, of course, equivalent to asserting that the hen plays at least an equal part with the cock in determining fertility. This is undoubtedly the case, for which detailed evidence has been presented elsewhere.** Since relatively poor fertility of the eggs is an undesirable characteristic c is put in the denominator of the index fraction. This case is the same in regard to d. If the chicks produced by a particular bird are weak and die early when given the same treatment as that under which other chicks thrive, it is an indication that that particular bird is not desirable as a breeder.

Summarizing, we believe the poultry selection index described, or some modification of it to suit particular needs, to be a useful aid in practical breeding operations with poultry. It measures in an exact and impartial manner the performance of a bird as a breeder in any given season. On the basis of the knowledge so gained the breeder can select birds which are to be retained for further breeding. It substitutes an exact and impartial measure, in the place of a rough, general impression of the relative effect of several variables.

The purpose of the paper here abstracted was to call the attention of those interested in breeding operations to the usefulness of what we have called "selection index numbers" in such work. The idea of such index numbers is to combine in a single numerical expression the values of a series of variable characters with regard to all of which the breeder wishes to practice selection at the same time. The analytical expression of this idea is discussed in the original paper and its adaptability and usefulness are illustrated by examples drawn from poultry and maize breeding. It is shown that selection index numbers form a valuable adjunct to the score card in stock judging.

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*Cf Me. Agric. Expt. Station, Bulletin No. 165, pp. 46-48.

**Me. Agr. Expt. Station, Bulletin 168.

POULTRY ABNORMALITIES.

During the past year two papers* dealing with abnormalities of poultry have been published. One of these deals with a case of hermaphroditism and the other with an abnormal egg. The purpose of studying such abnormalities as these is to gain light from them in an indirect way on the normal physiology of egg production. An abnormal specimen is, in a sense, the result of an experiment performed by nature. From such specimens facts of great importance for the interpretation of normal processes may often be learned.

The hermaphrodite specimen may be first considered. From a chick hatched in the spring of 1907, at the Maine Agricultural Experiment Station, there developed the bird which forms the subject of this abstract. This bird was a Barred Plymouth Rock and when adult presented externally the general appearance of a normal hen of this variety, so far as the characters body form and plumage color were concerned (cf. Fig. 81). As the photograph in Fig. 81 shows, however, the head and neck resembled these parts in a cockerel. This resemblance was especially remarkable in respect to the size and shape of the comb and wattles. The comb was obviously much larger than the comb of a normal Barred Plymouth Rock hen and looked exactly like the comb of a male bird. This was also true of the wattles.

The dimensions* of the comb of this bird were as follows:

Length	88.4 mm.
Calculated height	25.1 mm.
Area	22.2 cm.

For normal adult Barred Plymouth Rock females the following average values for comb size have been found: **

Mean length	$50.80 \pm .56$ mm.
Mean calculated height	$10.57 \pm .23$ mm.
Mean area	$5.59 \pm .17$ cm.

*These papers are (1) Studies on the Physiology of Reproduction in the Domestic Fowl. III. A Case of Incomplete Hermaphroditism. Biol. Bulletin, Vol. XVII, pp. 271-286, 1909. (By R. Pearl and Maynie R. Curtis). (2) A Triple Yolked Egg. Zool. Anzeiger, 1910. (In press). (By R. Pearl).

*Made in accordance with the methods described by R. and M. D. Pearl in a paper "Data on Variation in the Comb of the Domestic Fowl." *Biometrika*, Vol. VI, pp. 421-423.

**Pearl, R. and M. D., *loc. cit.*, p. 427.

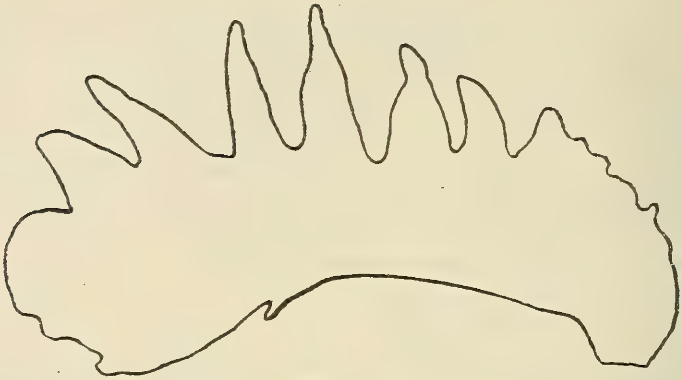


Fig. 80. Outline of the lateral aspects of the comb of the Barred Plymouth Rock hen described in this paper. This outline is actual size.

It is evident from these figures that the comb in this specimen greatly exceeds in size the average for females of the variety.

In regard to behavior this bird resembled a normal hen rather more than a cock. She was never heard to cluck, however, or to make any of the sounds which normal active hens make in the course of the day's work. This bird probably never laid an egg, though we are unfortunately not able to make an absolute statement on this point. The egg records of the Station show an egg to the credit of this bird on November 7, 1907. This was the only egg ever recorded for this bird, and it is undoubtedly an erroneous record. The condition of the sexual organs was not such as to indicate that they had ever been functional.

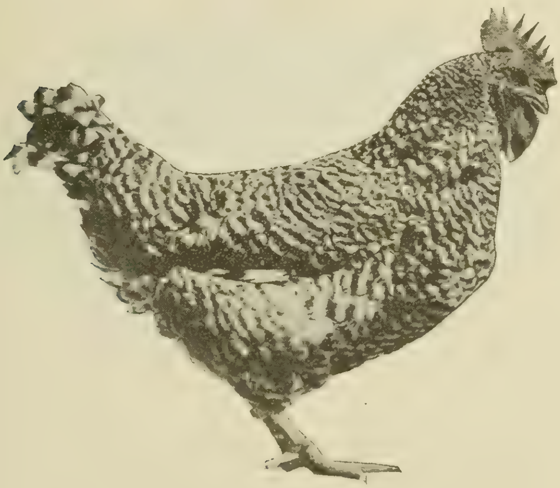
Cockerels placed in the pen with this bird would try to fight with her as if she were a cockerel, but she would not fight. We have no evidence that a cockerel ever attempted copulation with this bird. These facts are of interest in relation to the question of the basis of sex-recognition and the assortative mating known to occur among fowls. Is a normal pullet with an unusually large comb less likely to have her eggs fertilized than a bird with a smaller comb?

This bird was observed occasionally to take the position of a cockerel about to crow and attempted to crow but never succeeded in very closely approximating the sound of a normal cock bird. The bird was never seen to attempt to tread a hen.

Anatomical study of this bird showed that on the left side of the body were organs normal to a female (ovary or egg cluster, and oviduct or egg tube). On the right side were organs like those normal to a male (testicle and vasdeferens—the tube which conveys the spermatozoa from the testicle to the outside). Microscopic examination showed that neither the male nor the female organs had probably ever been functional.

The appearance of this hermaphrodite is shown in Fig. 81. Anteriorly the bird was male in its external characters; posteriorly it was female. The truth of this statement may be demonstrated in a striking manner by placing the edge of an opaque card along a line connecting the letters *a* and *b* in Fig. 81 and turning the card about this edge as an axis so as to expose alternately the anterior and posterior parts of the bird.

a



b

Fig. 81. Hermaphrodite Barred Plymouth Rock.

When the card covers the posterior part of the bird what one can see (*i. e.*, the anterior part) is unmistakably and indubitably male. On the contrary, when the anterior part is covered by the card, what of the bird is then to be seen is equally unmistakably female. The "maleness" and "femaleness" of these two portions of the body extend to the most minute details of structure, perhaps not apparent to anyone not perfectly familiar

through first-hand practical experience with poultry and particularly Barred Plymouth Rocks. Thus the beak—which is not ordinarily reckoned as a secondary sexual character—in this bird is to the fancier unmistakably that of a male.

The triple yolked egg shown in Fig. 82 was laid September 27, 1909, by a Barred Plymouth Rock pullet bearing the leg-band number 318. This pullet was hatched March 29, 1909. Its growth and physiological development were normal. During the spring and summer this chick was kept with others in a large field of grass, where it was under free range conditions. On September 1, 1909, this pullet, along with others, was put into the poultry-house which provides permanent winter quarters. She began laying about three weeks after this removal to the house. Her complete laying record to the date of writing is as follows:

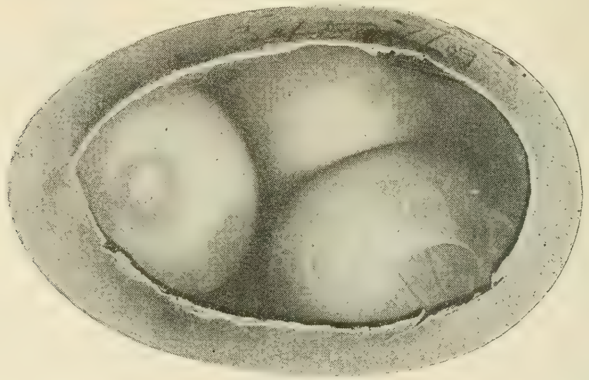


Fig. 82. Photograph (approximately natural size) of the triple yolked egg described in the text.

One egg was laid by bird No. 318 on:—

September 21, 24, 25, 26, **27**, 30.
October 2, 3, 4, 5, 8, 12, 13, 16, 17, 19.

So far as is known the first three eggs laid by this bird were entirely normal. That laid on September 26 was "soft-shelled," *i. e.*, bore only the shell membrane as an outside covering, with only a slight deposit of lime in the form of a true shell. This was followed on the 27th by the triple yolked egg. Since that date the eggs from this bird have been normal. The laying of the "soft-shelled" egg and the triple yolked egg on successive

days indicates that the whole reproductive mechanism was not functioning in a normal, orderly and regular manner at that time. The egg record at the time of laying of the triple yolked egg indicates the reason of its formation. From the 24th to the 27th inclusive the bird laid an egg each day. The egg of the 27th has three yolks. On the 28th and 29th no eggs were laid, but one was on the 30th. There should appear to be little doubt that one of the extra yolks in the triple yolked egg should normally have been laid in an egg of the 28th, and the other in an egg of the 29th. Instead of this, however, the three yolks which normally should have been laid on the 27th, 28th and 29th were all discharged from the ovary at so nearly the same time as to pass down the oviduct in one group. The case simply indicates that perfect *regularity* in rate of ovulation had not become firmly established at this time.

Bird No. 318 belongs to a family of relatively high fecundity. Her mother laid 177 eggs between November 16 and July 31 inclusive of her pullet year. This is a record well above the average for the general flock of that year 1908-09. The records show no abnormal eggs as having been produced by either the mother or the grandmother or sisters of bird No. 318 except for an occasional "soft shelled" specimen. There is thus no evidence of an inheritance of the tendency to lay multiple yolked eggs in this family. Experience in this laboratory where detailed records of large numbers of birds are kept shows that any individual is liable to produce at some time in her laying career an abnormal egg. If even mother and daughter should both chance to do this in one or two isolated instances it is no proof of inheritance.

The rarity of the occurrence of triple yolked eggs is indicated by the statement of a French scientist, Valenciennes, to the effect that the marketmen of Paris estimated that such eggs were found not more than 5 or 6 times in a year, at a time when the annual official receipts of eggs amounted to over 141 millions.

The disposition of the three yolks in this egg is clearly shown in Fig. 82. Each yolk was enclosed in a separate yolk membrane. While the three yolks were in contact with each other, they were in no way fastened together. All of the yolks were of normal size, and of approximately the same size. Unfortunately no measurement of the yolks are available. Each yolk

possessed a germ disc. These were normal so far as macroscopic appearance indicated. The germ disc on the yolk nearest the pointed end of the egg shows very clearly in Fig. 82.

The two kinds of albumen (of thick and thin consistency) which are normal were present in this egg. There was no trace of a chalaza in connection with any yolk or at either pole of the egg.

The shell membranes were entirely normal.

It is shown that, in so far as the four different classes of eggs in respect to the number of contained yolks which are known to occur, the relation of the observed size of the entire egg (measured here by weight) to the number of yolks, is very accurately described by a parabola.

BULLETIN No. 180.

THE MYCETOPHILIDÆ OF NORTH AMERICA.

PART II.*

THE SCIOPHILINÆ.

O. A. JOHANNSEN.

The classification which I adopted in *Genera Insectorum* is followed in this paper; the only exception being that *Neoempheria* is here restored to generic rank. To avoid confusion it may be well to state that *Lasiosoma* Winnertz of earlier writers is replaced by *Sciophila* (Meigen, part, not Winnertz) and *Sciophila* (*in sensu* Winnertz) by *Mycomya* Rondani. In the study of the members of this family alcoholic material is much to be preferred to pinned specimens. Slide mounts are also very useful though the ocelli and the parts of the hypopygium are not so readily discernible.

The subfamily *Sciophilinæ* is a compact and easily recognizable group characterized by the presence of a small closed cell (R_1) not far from the middle of the wing (figs. 83-106). The M-Cu crossvein is absent, R_{2+3} is distinct, short, usually nearly transverse, crossvein-like, and bounds distally the small cell R_1. The ocelli, two or three in number, are remote from the eye margin, except in the genus *Eudicrana*. The hypopygia are complex, diverse in structure and frequently small and inconspicuous.

Habits and Early Stages.

Comparatively little is known of the habits of the *Sciophilinæ*. In the paper on "Characters of the larvæ of Mycetophilidæ" by Osten Sacken, is given all that is known concerning the early

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*Papers from the Maine Agricultural Experiment. Entomology No. 42. Part I was published in Bulletin No. 172. Where the types of the new species are to be found will be stated in Part III, now in preparation.

stages of the members of this subfamily. He states that the larvæ of *Sciophila* are easily distinguished from those of *Mycetophila* by their more elongate form and their mode of life, as they do not burrow inside of the fungi, but live on the surface, generally on the under side of the pileus, which they cover with a web. Some of them are found on decaying wood, especially when it is covered with *byssus:* The head of the larva is more elongate than in the *Mycetophilinæ;* the antennæ are rudimentary; mandibles uniformly thin, slightly concave, with several large indentions and some minute ones in their intervals and on the surface; maxillæ well developed and apparently with a vestigial palpus. The body is 12-segmented, subcylindrical, elongated, almost serpentine, yellowish in color with 8 transverse rows of exceedingly minute ambulacral setulæ on the ventral side of abdomen. The stigmatæ are small, 8 pairs, one on the first thoracic and seven on the first 7 abdominal segments, the last two having none.

Winnertz records rearing *Neoempheria, Empalia* and *Mycomya* from decaying Beech wood, the last also from the fungi *Daedalea quercina,* and *Polyporus; Sciophilæ* (*Lasiosoma*) were obtained from the fungi *Hydnum repandum, Boletus scaber,* and *Daedalea quercina.*

Table of Genera.

a. Cubitus not forked (fig. 84); forceps slender (fig. 107). 1. *Monoclona.*

aa. Cubitus forked.

b. Two ocelli, one near each eye margin; petiole of cubitus very short (fig. 83). 2. *Eudicrana.*

bb. When only two ocelli are present these closely approximated and widely remote from eye margin; frequently with three ocelli.

c. The R-M crossvein long and oblique, appearing like the beginning of a longitudinal vein and much longer than the small transverse basal section of the radial sector (fig. 85). 3. *Tetragoneura.*

cc. The crossvein shorter or not much longer than the base of the radial sector.

d. The media forks slightly distad of the crossvein but proximad of the fork of the cubitus (fig. 86). (*Lasiosoma* Winn). 4 *Sciophila.*

dd. The media forks at least the length of the crossvein beyond the latter and distad of the fork of the cubitus.

e. Ocelli widely separated, the middle one distinct and but little if any smaller than the laterals.

f. The subcostal crossvein placed noticeably proximad of the cell R_1 which is three or more times as long as broad, *and* the subcosta ends in the costa; conspicuour hairs on the wing among the setulæ (fig. 87). 5. *Paratinia.*

ff. Not with the above combination of characters.

g. R_{4+5} much curved and often undulate, cell R_1 usually shorter than broad, subcosta ends either free or in the costa beyond the cell R_1 (figs. 88-90). 6. *Polylepta.*

gg. R_{4+5} straight or gently arched; the cell R_1 as long or longer than broad (except in *Empalia*).

h. Subcostal crossvein is proximad of the small cell R_1 which is shorter than broad (fig. 91); apex of subcosta may be obliterated. 7. *Empalia.*

hh. Subcostal crossvein, when present, is placed on the cell R_1.

i. Subcostal vein ends in R_1; small cell usually more than twice as long as broad; petiole of the cubitus rather short; middle femur of male without a stout spine at apex.

j. Proboscis prolonged, snout-like (fig. 61, pt. 1); anterior veins unusually heavy (fig. 93). 8. *Hadroneura.*

jj. Proboscis not prolonged; anterior veins only moderately thickened (fig. 92). 9. *Dziedzickia.*

ii. Subcostal vein ends in the costa, small cell less than twice as long as broad; wing with markings (fig. 94); apex of middle femur of male with a stout spine. 10. *Diomonus.*

ee. Ocelli close together, the middle one if present very minute.

f. Wing with bands or markings; costa usually produced beyond the tip of R_{4+5}; wing usually with a longi-

tudinal fold between radius and media (figs. 95 to 100); eyes usually not emarginate.

11. *Neoempheria.*

ff. Wing hyaline, without dark fasciæ or spots; costa usually meets R_{4+5} at tip of wing (figs. 101-106); eyes usually emarginate at base of antennæ; *Sciophila* Winn). 12. *Mycomya.*

1. Genus *Monoclona* Mik.

Monoclona, Mik, Wien. Ent. Zeit. V. 279 (15) (1886).
Stægeria, Van der Wulp, Tijdschr. v. Ent. XIX. versl. 49 (1876)

Resembles *Sciophila* (*Lasiosoma*) but differs mainly in having a simple cubitus. Head small, flattened above; eyes oval, slightly emarginate at base of the antennæ; ocelli three, placed high upon the front, widely separated, the middle one but little smaller than the laterals; antennæ projecting forward, arcuated, 2+14 jointed, the basal joints differentiated, cupuliform, the flagellar joints rounded, short haired; palpi incurved, four jointed, apical joint longest, cylindrical. Thorax highly arched, with bristle-like hairs. Abdomen slightly constricted at the base, with seven visible segments, in the male cylindrical, in the female slightly depressed. Legs moderately long, the tibiæ with fine lateral setæ and long spurs; the fore tarsi twice as long as the tibiæ. Halteres large and with elongate knobs. Wings hairy (fig. 84), broad, longer than the abdomen; costa produced beyond the tip of R_{4+5}; subcosta ends in the costa far distad of the small cell R_1, this cell short, R-M crossvein a little longer than its distance from the fork of the media; Sc_2 (subcostal crossvein) a little proximad of the small cell; cubitus simple. The genitalia of the male rather slender and elongate, the lateral lobes prolonged, and curved forceps-like (fig. 107).

Monoclona elegantula n. sp.

Male and female. Length 3 mm. Head black, palpi, face, scape of antenna, and the two basal joints of flagellum yellow, the remaining flagellar joints fuscous. Thorax yellow, the mesonotum variable, in one specimen with three confluent blackish stripes, in the others with the lateral stripes dark, the middle one only faintly indicated. In the darkest specimens the scutellum and metanotum are infuscated, in the others these parts are yellow; hairs pale. Each intermediate abdominal segment

yellow with a broad brown fascia which in the darkest specimen covers all but very narrow incisures; in the paler specimens the yellow predominates; the last two or three segments in all the specimens wholly dark brown; venter yellow; hypopygium (fig. 107) dark brown, ovipositor yellow. Legs yellow, tarsi somewhat darker, foremetatarsus eight-tenths, the second fore tarsal joint half as long as the tibia; tarsal claws each with a tooth at the base, empodium prominent, brush-like. Wings (fig. 84) yellowish hyaline, veins dusky yellow; the small cell shorter than wide, trapezoidal, wider on anterior margin, in this respect differing from *M. halterata*. Stem of the halteres yellow, the elongate knob black. In one wing of one specimen R_{2+3} is wanting, thus making a venation exactly like that of *Acnemia*.

Four males and one female taken in August, Ithaca, N. Y. See page 187 for an additional species.

2. Genus *Eudicrana* Loew.

Eudicrana, Loew, Berl. Ent. Zeitschr. XIII, 142. 1869.

Lateral ocelli contiguous to the eye margin, the middle ocellus absent. Legs slender; tibial setæ moderate; spurs long. Wings (fig. 83) large, of moderate width and rather hairy; costa produced beyond the tip of R_{4+5}; subcostal vein ends in the costa; subcostal crossvein present; basal cell R rather short; cell R_1 elongate; cells in the forks of media and cubitus very long, acuminate at the base, the fork of the latter proximad of the R-M crossvein; second anal strong, long, but not reaching margin of the wing.

Eudicrana obumbrata Loew.

1869. *obrumbrata,* Loew, Berl. Ent. Zeitschr. XIII. 141.

Female. Length 6 mm., wing 5 mm. Head fuscous-black, lower half of the face, cheeks and palpi pale yellow. Scape of antenna yellow, the flagellum fuscous-black. Mesonotum, scutellum and metanotum yellow, with the longer and stronger setæ black, the pile, fuscous. Pleura pale yellowish, near the coxæ mottled with black. The first two abdominal segments and the last, black; the remainder maculate with black; ovipositor short, yellow. Coxæ pale yellow, the heavier pile black, the delicate pile, pale. Legs pale yellowish, the tibial spurs and the tarsi fuscous. Wings subcinereous, the apex and the pos-

terior margin with cinereous cloud; subcosta ends in the costa a little proximad of the apex of cell R_1; the petiole of the media shorter than this cell; base of the fork of the cubitus under the center of the R-M crossvein. Halteres pale. Recorded from New York.

Male. Length 8½mm., wing 6 mm. Face wholly yellow, pile of face and eyes yellow, mesonotum with three broad pale brown stripes, covered with fine yellow pile, setæ of humeri and at the base of the wing black; setæ on lateral margins fuscous; dorsal surface of scutellum and metanotum infuscated, setæ of the former short, the latter with an irregular transverse row of long black ones over the base of the abdomen; setæ of posterior part of pleura, long, fine, and pale yellow. The basal half or two-thirds of the second, third, fourth and fifth abdominal segments and the hypopygium (fig. 111) yellow, the remaining parts black, setulæ black on the black parts and yellow elsewhere. Tibial setæ longer than the diameter of the tibiæ, black, and arranged in about four longitudinal rows; one spur on each fore tibia; two on each of middle and hind tibiæ; fore metatarsus one and three-eighths, the second fore tarsal joint two-thirds as long as the tibia; all claws with two teeth each. Brownish cloud covers the apical fourth of the wing (fig. 83); subcosta ends very slightly distad of the cell R_1. In other respects like the female. One specimen collected by Mr. C. W. Johnson at Capens, Maine, in July.

3. Genus *Tetragoneura* Winnertz.

Tetragoneura, Winnertz, Stett. Ent. Zeit. VII. 18. 1846.

Head spherical, flattened in front, placed low upon the thorax; eyes circular, bulging; ocelli three in number, placed in a curved line upon the broad front, the middle one smaller than the laterals; palpi incurved, four jointed, the first joint very small, the fourth long, filiform; antennæ arcuated, projected forward, 2+14 jointed, the first two differentiated, both long setose at the apex, the flagellar joints cylindrical, slightly compressed, short pilose. Thorax oval, highly arched; scutellum small, truncated behind, long setose; metanotum highly arched. Abdomen seven segmented, cylindrical in the male, with short forceps (fig. 108); in the female somewhat compressed, terminating in an ovipositor with two lamellæ. Legs moderately long; femora compressed, all tibiæ with lateral setæ. Wing (fig. 85) some-

what longer than the abdomen, microscopically setulose, oval, with more or less rounded base; costa produced far beyond the tip of R_{4+5}, but not quite reaching the tip of the wing; subcosta short or long, ending in the costa, or free, or in R_1; R_1 ending in the costa beyond the middle of the wing; Sc_2 (subcostal crossvein) usually wanting; the small cell (R_1) somewhat elongate, beyond the middle of the wing; the R-M crossvein elongate, very oblique, almost longitudinal in position, appearing like the beginning of a longitudinal vein; petiole of the media moderately long; cubitus forking either near the base of the wing or somewhat distad of this point; anal veins vestigial. The larvæ have been found in rotten wood and in fungi.

Table of Species.

a. Subcosta ends in the costa; a fossil species from Colorado. 1. peritula.

aa. Subcosta does not end in the costa; living species.

- b. Subcosta vestigal, ends free (fig. 85) thorax and abdomen shining black. 2. *nitida.*
- bb. Subcosta ends in R_1 nearly midway between humeral crossvein and the base of the radial sector.
  - c. Abdomen yellow; cubitus forks near its base. N. H. 3. *bicolor.*
  - cc. Abdomen brown, posterior margins of second and following segments yellow; cubitus forks at a point nearly opposite the proximal end of the R-M crossvein. Pa. 4. *pimpla.*

1. *Tetragoneura peritula* Cockerell.

1909. *peritula,* Cockerell, Amer. Jour. Science XXVII, 53.

A fossil species from the Florissant, Colorado.

2. *Tetragoneura nitida* Adams.

1903. *nitida,* Adams, Kan. Univ. Science Bul. II. 23.

Female. Length 2.7 mm. Black, shining; head black, front bearing yellow pile, antennæ dark brown, first two joints and palpi yellowish; mesonotum black, shining, pile yellow, bristles on margins black, scutellum black, bristles yellow, metanotum and pleura black, halteres yellow, abdomen wholly shining black, pile yellow; legs yellow, with tip of hind femora, middle and hind tibiæ and all tarsi brown; wings hyaline, tinged with brown on the anterior part, subcosta short, ending free, the

furcation of the cubitus is nearly opposite to the proximal end of the R-M crossvein. Recorded from Missouri (May).

Male. Wing shown in figure 85. Differs from female only in having yellow and black setæ on the margin of the mesonotum; the trochanters are margined with black. The fore metatarsus is two-thirds, the second fore tarsal joint one-third as long as the tibia; the hypopygium is minute and very inconspicuous (fig. 108). A single specimen from L. Toxaway, N. C.

3. *Tetragoneura bicolor* Coquillett.

1901. *bicolor*, Coquillett, Proc. U. S. Nat. Mus. XXIII. 595.

Female. Length 3.5 mm. Head black, first two joints of antennæ and the mouth parts yellow, remainder of antennæ dark brown; thorax and scutellum black, somewhat polished, the hairs reddish brown and black; abdomen yellow, its hairs also yellow; halteres, coxæ, femora, and tibiæ yellow, apices of tarsi brownish yellow; wings hyaline, subcostal vein ending in R_1 about midway between the humeral crossvein and base of the radial sector; cubitus forking close to its base; length 3.5 mm. N. H.

4. *Tetragoneura pimpla* Coquillett.

1901. *pimpla*, Coquillett, Proc. U. S. Nat. Mus. XXIII. 595.

Female. Length 4.5 mm. Head black, base of antennæ and mouth parts yellow; body brown, two indistinct vittæ and lateral margins of mesonotum, a spot above front coxæ, posterior margins of second and following abdominal segments, and the the genitalia, yellow; hairs and bristles of thorax black, those of abdomen chiefly yellowish brown; coxæ and femora yellow, tibiæ and tarsi brownish yellow, halteres yellow; wings grayish hyaline, the subcostal vein ends in R_1 nearly midway between the humeral crossvein and base of the radial sector, cubitus forks near its middle, at a point almost opposite the union of the small crossvein with the media. Pennsylvania.

4. Genus *Sciophila* Meigen.

Sciophila, Meigen, Syst. Beschr. I. 245. 1818.

Sciophila, Rondani, (nec Winnertz), Dipt. Ital. Prodr. I. 194. 1856.

Lasiosoma, Winnertz, Verh. Zool-bot. Ges. Wien. XIII. 748. 1863.

The name *Sciophila* is used here in the sense of Rondani (1856) and includes all the species classified by Winnertz (1863) in the genus *Lasisoma,* the latter thus becoming a synonym of the former. The species which Winnertz placed in *Sciophila* are transferred to *Mycomya,* Rondani, where they rightfully belong.

Head small, spherical, flattened in front, placed low upon the thorax; eyes oval, slightly emarginate at the base of the antennæ, almost reniform; ocelli three in number, arranged in a flattened triangle upon the broad front or more rarely upon the vertex, the middle one only slightly smaller than the laterals; palpi incurved, four jointed, the first joint very small, the second and third subequal, the last longer than the others taken together; antennæ projecting forward, arcuated, somewhat compressed, 2+14 jointed, the two basal joints cupuliform, hairy. Thorax oval, highly arched mesonotum long and thickly haired, not setose; scutellum very small; halteres with short petiole and elongate knob. Abdomen with seven visible segments, cylindrical, somewhat constricted at the base, hairy, in the male with blunt extremity and small forceps (fig. 110, 117). Legs moderately long; the tarsi of the fore legs double the length or rarely more than double the length of the tibiæ. The tibiæ with spurs and with lateral setæ, the fore pair with one or two, the middle pair with three and the hind pair with four rows, the inner row with only few and weak setæ. Wings elongate oval, with rounded base, longer than the abdomen, hairy, hairs sometimes visible with the naked eye. The costa produced far beyond the tip of R_{4+5}, but not reaching the tip of the wing; the subcosta usually extends distad of the small cell and ends in the costa; the cell R_1 very small and usually rectangular; the media forks at or but very little distad of the R-M crossvein; the cubitus forks noticeably distad of the fork of the media; the anal vein incomplete, ending far from the margin of the wing (fig. 86).

These flies are prevalent in Spring and Fall; the larvæ live in rotten wood and in fungi.

Table of Species.

a. Wing 2.40 (or less) times as long as the fore tibia; yellow species.

b. Halteres luteous; subcosta ends at least the length of the crossvein beyond the latter; female.

11. *similis* n. sp.

bb. Halteres with black knob; inferior forceps of hypopygium (fig. 110) with very short, stout, blunt spines, no palmate spines (compare 12 *fasciata* Say).

c. Subcostal crossvein at distal end of small cell.

2. *glabana* n. sp.

cc. Subcostal crossvein near middle of small cell.

d. Small cell (R_1) about one and one-half times as long as wide.

2a. *glabana;* var. *germana,* n. var.

dd. Small cell about twice as long as wide; subcosta ends less than the length of the small cell beyond the latter.

2b. *glabana;* var. *socia,* n. var.

aa. Wing 2.75 (or more) times as long as the fore tibia.

b. Small species 2.75 mm. in length; thorax yellow, with three blackish stripes confluent posteriorly, abdominal segments fasciate; inferior forceps lobular, apically with a number of long setæ, convex basal part with palmate spines (fig. 115).

3. *nugax* n. sp.

bb. Larger species, over three mm. long; inferior forceps with two long blunt spines directed mesad (fig. 117).

c. Thorax mainly yellow, dorsum sometimes with faint indications of fuscous stripes.

d. Subcostal crossvein inserted at the base of small cell R_1.

e. Dorsal plate of hypopygium produced into a serrate spur, with 3 or 4 long setæ (fig. 109); inferior forceps with 2 long blunt spines on dorsal surface; superior forceps, slender, curved (fig. 109a); abdomen fasciate. 4. *habilis* n. sp.

ee. Dorsal plate of hypopygium slightly emarginate, with 2 long, slightly and sparsely plumose setæ (similar to fig. 117); superior forceps not produced beyond the margin of the dorsal plate; inferior forceps with 3 long blunt spines (similar to fig. 119s); abdomen subfuscous, nearly unicolored. 5. *incallida* n. sp.

dd. Subcostal crossvein inserted at the middle of small cell R_1. 1. *quadratula*.

cc. Thorax mainly dark.

d. Superior forceps curved, large, broadened at the end (fig. 113a), inferior forceps with 2 dorsal spines and 1 very strong ventral, laterally directed spine (fig. 113b). 6. *hebes* n. sp.

dd. Superior forceps hidden; no strong spine on ventral surface of inferior forceps.

e. With 3 blunt spines (s) on dorsal lobe of inferior forceps (fig. 119). 7. *novata* n. sp.

ee. With 2 blunt spines (s) on dorsal lobe of inferior forceps (fig. 116).

f. Margin of dorsal plate of hypopygium with 8 to 10 slightly plumose setæ, sometimes directed inwards; dorsal lobe of inferior forceps with its 2 blunt spines, strongly developed (fig. 116s). Western species. 8. *impar*. n. sp.

ff. Margin of dorsal plate with fewer plumose setæ.

g. Thorax fuscous, pleura brownish; margin of dorsal plate of hypopygium with no plumose setæ. 9. *severa* n. sp.

gg. Pleura blackish; margin of dorsal plate with 2 sparsely plumose setæ (similar to fig. 117s), (compare 13 *hirta* Meigen and *Polylepta grisea* Walker). 10. *pallipes* Say.

Sciophila fasciata Say (12), *Sciophila popocatepetli* Bell. (14), and *Sciophila* (*Lasiosoma*) *hirta Meigen* (13) are not included in the above table. The two former may not even belong to this genus; the latter, reported from Greenland, may be distinguished from *S. pallipes* by its wholly black antenna and scape. *Sciophila grisea* Walker may be a *Polylepta,* though as likely may be a synonym of *S. pallipes* Say. *S. mirandula* Cockerell is a fossil species from Colorado.

1. *Sciophila quadratula* Loew.

1869. *quadratula,* Loew, Berl. Ent. Zeitschr. XIII. 141 (*Lasiosoma*).

Female. Length 3 mm.; wing 2.8 mm. Luteous, clothed with pale pile. Head and flagella of antennæ fuscous black, scape reddish, palpi pale yellowish. Mesonotum not vittate, metathorax more or less fuscous. Abdomen fuscous black, the posterior margin of each segment more or less pale, the apex of abdomen luteous. Legs and coxæ yellowish, the tarsi except the base, fuscous, the more slender veins paler; cell R_1 small, quadrate, the subcostal crossvein placed at the middle; the furcation of the media about opposite the apex of the subcosta. Halteres yellowish. Recorded from Maine. After examining the type I may add that the wing is over three times as long as the fore tibia, the distance from the humeral crossvein to the subcostal crossvein is about 2-3 greater than from the latter to the tip of the subcosta, and that the cubitus forks proximad of the tip of the subcosta.

2. *Sciophila glabana* n. sp.

Male. Length 5.5 mm.; wing 4 mm. Head reddish, infuscated, especially around the ocelli; face, palpi, and scape of the antenna yellow, flagellum fuscous, intermediate joints over 1.5 times as long as wide, ocelli in a transverse line. Thorax yellow, with a minute brown spot at the root of the wing; setæ yellow. Abdominal segments brown with both the anterior and posterior margins yellow; hypopygium shining yellow, the blunt spines of the inferior forceps fuscous; terminal flap of dorsal plate provided with 6 strong marginal and several distal setæ (fig. 122); superior forceps slender, somewhat curved and each limb with a strong terminal seta; the inferior forceps short, ovate, the apex with a number of stout, blunt but short spines

(fig. 110). Coxæ and legs yellow, trochanters with black tips, tarsi subfuscous, empodium bushy; each claw with a single tooth; setæ of fore and middle tibiæ very small, sparse, those of the hind tibiæ on the lateral and extensor surfaces about 6 or 7 in each row, the longest about as long as the diameter of the tibia; fore metatarsus and tibia subequal, the second tarsal joint about 0.6 as long. Wings yellowish hyaline, veins brownish yellow; the distance from the humeral crossvein to the subcostal crossvein 4 times as great as from the latter to the tip of the subcosta; the subcostal crossvein is placed near the distal end of cell R_1, the latter is about 1.5 times as long as wide; petiole of the media is about 0.5 as long as the R-M crossvein; the cubitus forks a very little distad of the tip of the subcosta; anal vein incomplete, but strong. Halteres yellow, with a black knob. Ithaca, New York; Polk Co., Wisconsin.

Var *germana* n. var. In one male from Polk Co., Wisconsin, collected in July by Professor Wheeler, the crossvein is near the middle of the small cell.

Var. *socia* n. var. Several male specimens from Burlington, Vermont, collected in June by Mr. C. W. Johnson, have similar hypopygium, structure and markings, but the small cell is about twice as long as wide; the subcostal crossvein is placed distad of the middle, the tip of the subcosta thus ending but little beyond the distal end of this cell. A female from Boston also belongs here.

Some female specimens from Milwaukee, Wisconsin, do not differ from *Var. germana* except that there are indications of three slender brownish lines on the mesonotum.

3. *Sciophila nugax* n. sp.

Male. Length 2.75 mm.; wing 2.5 mm. Head fuscous, antennæ fuscous apically, basal joints, face, mouth parts and palpi yellow; hairs of head and antennæ yellow, intermediate antennal joints over 1.5 times longer than wide. Thorax yellow, subshining, mesonotum with 3 brownish longitudinal stripes, abbreviated and paler anteriorly, dark, converging and almost meeting posteriorly just in front of scutellum; metanotum brownish, thoracic hairs yellow. Abdomen reddish yellow, median transverse fascia on the intermediate segments black, posterior segments more blackish; hypopygium yellow. Dorsal plate of hypopygium (appendix externa) triangular in outline; apical

angle acute, setose; superior forceps much reduced, claw-like and hidden under the dorsal plate; inferior forceps lobular, apex fleshy with a score of long setæ ranged along the side, three long setæ near the base of this part, the convex part provided with about 20 small palmate spines, the ventral aspect setose (fig. 115). Coxæ yellow, trochanters tipped with black, legs yellow, tarsi slightly darker; fore tibiæ with 3 or 4 very small setæ on flexor surface; middle tibiæ with 3 or 4 on flexor surface, and 4 or 5 both inwardly and outwardly on extensor surface; hind tibia with 3 or 4 on inner lateral surface, 4 on inner extensor surface, about 12 on outer extensor surface in 2 rows, the longest about as long as the diameter of the tibia; empodium bushy; claws each with a single tooth; fore metatarsus and tibia subequal, the second fore tarsal joint half as long. Wings yellowish hyaline, veins yellowish; distance from the subcostal crossvein to the apex of the subcosta is about 0.6 as far as from the humeral to subcostal crossvein; the latter stands on the basal third of the small cell which is slightly longer than broad; the petiole of the media is about as long as the R-M crossvein; the cubitus forks slightly distad of the end of the subcosta; anal vein long, incomplete, delicate. Halteres yellow. Ithaca, New York, August.

A defective male specimen from Price Co., Wisconsin, collected in August by Professor Wheeler, probably also belongs

4. *Sciophila habilis* n. sp.

Male. Length 4 mm.; wing 3 mm. Head black, antennæ fuscous, yellow at the base, face, proboscis and palpi dusky yellow to subfuscous, hairs yellow; intermediate antennal joints one and one-half times as long as broad. Thorax wholly yellow with only a small spot at base of metanotum and some small specks on pleural sutures, blackish; hairs yellow. The first and second abdominal segments, the posterior margins of the third and fourth dorsally and basal half of venter yellow, remaining parts including hypopygium black; hairs yellow, mingled with black hairs posteriorly. Hypopygium of the *pallipes* type, the dorsal lobe of the inferior forceps (resembling those of fig. 117) with about 18 palmate spines and 2 blunt dorsal spines, the superior forceps (fig. 109) slender, much curved, the dorsal plate (appendix externa) prolonged into a serrate spur with 3 or 4 strong setæ which are branched (almost pal-

mate) near the tip. Coxæ yellow, trochanters with conspicuous black spot at the tip, legs yellow, tarsi somewhat infuscated. Flexor surface of fore tibiæ with about 8 black setæ; middle tibia with about 6 on the flexor surface, 6 on extensor surface inwardly, and 4 longer ones outwardly, the last nearly as long as the diameter of the tibia; hind legs with 4 on inner lateral surface, 8 on inner extensor surface, about 12 on outer extensor surface in 2 rows, the longest a little longer than the diameter of the tibia; empodium bushy; claws each with a single tooth; fore metatarsus about 0.9, the second tarsal joint about 0.5, the wing about 3 times as long as the tibia. Wings yellowish hyaline, veins dusky yellow; distance from humeral crossvein to the subcostal crossvein about 0.2 greater than the distance from the latter to the tip of the subcosta; small cell nearly rectangular, shorter than wide; the subcostal crossvein inserted at the base of this cell; petiole of the media about as long as the R-M crossvein; cubitus forks slightly distad of the tip of the subcosta; anal vein strong though incomplete. Halteres yellow. Ithaca, New York.

Female. Differs in having paler antennæ; abdomen with markings paler brown and less extensive.

5. *Sciophila incallida* n. sp.

Male. Length 3½ to 4 mm. Yellowish. Thorax pale yellow, mesonotum an infuscated disk with indications of three longitudinal stripes; abdomen nearly unicolored dusky yellow to brownish; legs pale yellow; fore metatarsus 0.9, the wing 3 times as long as the fore tibia; wing venation and hypopygium as in *S. novata*, the hypopygium differing only in having 22 to 24 palmate spines on the dorsal lobe of the forceps. Ithaca, New York.

6. *Sciophila hebes* n. sp.

Male. Length 4 mm. Subshining brownish black, the 2 basal joints of antennæ, coxæ, trochanters, legs and halteres yellow; tips of trochanters and apices of tarsi dusky. Body hairs yellow, setæ of legs black. Intermediate antennal joints about 1.5 times as long as wide. Margin of the dorsal plate of the hypopygium is convex with 4 longer sparsely feathered setæ, besides the usual shorter setæ; superior forceps are much curved, ends broadened, spoon shaped (113a) and without setæ;

each member of the inferior forceps (fig. 113) have the usual pair of mesad projecting spines, the usual pair of dorsal spines, a single very stout ventral, outward projecting spine (b) and a hood surmounted by 40 or 50 palmate spines. Fore tibia with 2 or 3 very small setæ on outer side; middle tibiæ with 4 on outer and 4 on inner extensor surface; hind tibia with 12 to 15 in 3 irregular rows on extensor surface; empodium brush-like; each claw with a single tooth; the second fore tarsal joint about half as long, the fore metatarsus subequal to the tibia in length. Wings hyaline, yellowish tinged, veins yellowish brown; subcostal crossvein placed at the base of the small cell, which is slightly shorter than broad, the distance of the humeral crossvein to the subcostal crossvein is 1.25 times as great as from the latter to the apex of the costa; cubitus forks under or very slightly proximad of tip of subcosta; anal vein strong but incomplete. Length of wing 3½ mm. Kingston, R. I., in May (Barlow); Lawrence, Kas. (Aldrich).

7. *Sciophila novata* n. sp.

Male. Length 4 mm. Subshining brownish black, halteres and legs including coxæ, yellow, body hairs yellow, basal joints of antennæ rather paler than the remainder. Fore metatarsus 15-16 as long as the tibia. Dorsal plate of the hypopygium (fig. 117) with a slightly emarginate posterior border and with a pair of long setæ (s) very sparsely feathered; superior forceps acute, much reduced, not produced beyond the dorsal plate; dorsal lobe of the inferior forceps (fig. 119) with 3 long slender but blunt spines (s) and 16 to 18 palmate spines arranged in more or less of a spiral, those outermost much longer and less crowded than the others; no stout spine on ventral side. Wing yellowish hyaline, veins yellowish; subcosta ends slightly proximad of the fork of the cubitus; the distance from the humeral crossvein to the subcostal crossvein about 1.25 times as far as from the latter to the apex of the subcosta; subcostal crossvein is placed close to the base of the small cell which is slightly longer than the R-M crossvein; anal vein strong but incomplete. Ithaca, N. Y., May. Several specimens.

8. *Sciophila impar* n. sp.

Male. Length 3.5 to 4 mm. Subshining brownish black, the two basal joints of antennæ, coxæ, trochanters (excepting their black apices) legs and halteres yellow. Body hairs yel-

low, setæ of the legs black. Intermediate antennal joints about 1.5 times as long as wide. Hypopygium resembles that of *S. novata* but the dorsal plate differs in having a convex margin with 8 to 10 long, curved, finely but sparsely pubescent setæ and in having the dorsal process of the inferior forceps much more strongly developed (fig. 116). Fore tibia has 1 or 2 small setæ outwardly, and 3 or 4 on flexor surface; middle tibia with 3 or 4 on inner and 1 on outer extensor surface, and 3 or 4 on outer flexor surface; hind tibia with 6 or 8 on inner and outer extensor surface; empodium brush-like, each claw with a single tooth; fore metatarsus is about 1-6 shorter than the tibia, the second tarsal joint about half as long. Wings hyaline, yellowish tinged, veins yellowish brown; the subcostal crossvein placed at or slightly before middle of the small cell R_1 which is about as long as broad, the distance from the humeral crossvein to the subcostal crossvein is twice as great as from the latter to the tip of the subcosta; the cubitus forks slightly distad of the tip of the subcosta; anal vein strong but incomplete. Length of wing is 3 mm., which is over 3 times as long as the fore tibia.

Female. Like the male but the ratio of wing to tibia slightly greater. Specimens taken in September at Jackson Lake, Wyoming, by Prof. W. M. Wheeler.

A male from Black Rock Creek, Wyoming, (Wheeler) and a female from Friday Harbor, Washington, (Aldrich) have the subcostal crossvein at the base of the small cell, and by transmitted light the abdomen has a yellowish tinge, otherwise as above.

9. *Sciophila severa* n. sp.

Male. Length 3.5 mm. In coloring like *S. hebes* but with rather more brownish thorax. Intermediate antennal joints about 1.5 times as long as broad. Dorsal plate of the hypopygium with slightly emarginate border but no plumose setæ; superior forceps somewhat curved with acute apex, only slightly projecting beyond the margin of the dorsal plate; inferior forceps (shown in fig. 112 with the dorsal lobe folded out) with 25 to 30 palmate spines on the dorsal lobe of which 4 or 5 are separated from the others; 2 slender dorsal spines (s), the stout spine on the ventral surface of the forceps of *S. hebes* is wanting in this species. Setæ of the legs as in *S. hebes;* fore metatarsus nearly a tenth shorter, the second tarsal joint slightly

over half as long as the tibia. Wing hyaline, yellowish tinged, veins yellowish brown; the subcostal crossvein is placed at the base of the small cell, which is slightly shorter than broad; the distance from the humeral crossvein to the subcostal crossvein is about 1.25 times as great as from the latter to the tip of the subcosta; the cubitus forks slightly distad of the tip of the subcosta; anal vein incomplete, delicate. Length of wing is 3 mm., which is nearly three times as long as the fore tibia. Ithaca, New York; July.

10. *Sciophila pallipes* Say.

1824. *pallipes,* Say, Long's Exp. St. Peter's River. App. 361.
1878. *pallipes,* Osten Sacken, Catalog. of Diptera. (*Lasiosoma*).

Male. Length 3.5 mm. Scape of the antennæ, halteres, femora and tibiæ yellow, tarsi brownish, remaining parts subshining brownish black, body hairs yellow. Fore metatarsus about 1-16 shorter, the second tarsal joint about 0.5, the wing 3 times as long as the tibia. Hypopygium is like that of *S. novata* but the dorsal lobe of each branch of the inferior forceps has 2 slender blunt spines and 28 to 30 palmate spines. The distance from the humeral crossvein to the crossvein is 1.6 times as great as from the latter to the tip of the subcosta; the subcostal crossvein is situated near the base of the small cell which is about as long as wide; petiole of the media is shorter than the R-M crossvein; the cubitus forks under or slightly proximad of the tip of the subcosta; anal vein is stout but incomplete. This species has been recorded by Say from the "Northwest Territory." My specimens were taken at Ithaca, New York, and Orono, Maine. The species has also been recorded from New Hampshire.

11. *Sciophila similis* n. sp.

Female. Length 5 mm.; wing 4.5 mm. Front and flagellum of antenna brown; scape, face, proboscis and palpi yellow; hairs yellow. Thorax yellow, without stripes; hairs yellow. Abdomen with the basal half and the narrow apical margin of each segment yellow, intervening space brown, hairs and ovipositor yellow. Legs yellow, tarsi slightly darker; fore metatarsus about 1-12 shorter than the tibia. The wing is less than 2.4 times as long as the fore tibia; yellowish hyaline; the distance from the humeral crossvein to the subcostal crossvein is

over 3 times as long as from the latter to the tip of the subcosta; the subcostal crossvein is situated slightly proximad of the middle of the small cell R_1, which is about 1.5 times as long as wide; the petiole of the media is less than half as long as the R-M crossvein; the strong anal vein ends about opposite the fork of the cubitus and slightly distad of the apex of the subcosta. Halteres yellow.

One specimen. Rigaud, Canada. June 25.

12. *Sciophila fasciata* Say.

1823. *fasciata,* Say, Journ. Ac. Phil. III. 26.

1878. *fasciata,* Osten Sacken, Catalog. Diptera. (*Lasiosoma*).

Length 6 mm. Yellow species; antennæ yellowish, brown apically; vertex brown. Mesonotum with pale brown longitudinally divided median stripe narrowed and abbreviated posteriorly; lateral stripes reddish brown abbreviated anteriorly; over the base of the wing with another smaller and less conspicuous stripe; pleura with a brown spot over each coxa, these spots arranged in a triangle, the lowest itself triangular. Abdominal segments with brown posterior margins. Wing slightly yellowish. Tibiæ and tarsi slightly infuscated. Recorded from Pennsylvania, Maryland, and New Mexico.

13. *Sciophila hirta* Meigen.

1818. *hirta,* Meigen. Syst. Beschr. I. 251.

1863. *hirta,* Winnertz, Verh. Zool.-bot. Ges. Wien. XIII. 749 (*Lasiosoma*).

Male and female. Length 3 to 4.5 mm. Shining black, or fuscous, including antennæ, palpi and tarsi; halteres, coxæ, legs, and body hairs yellow. Wings fuscous tinged; cell R_1 small, square; subcostal crossvein placed at or slightly proximad of the middle of this cell. Fore metatarsus 13-16 as long as the tibia.

This form which has been recorded from Greenland may be distinguished from other dark colored species by its wholly black antennæ, and by the location of the subcostal crossvein with respect to the small cell.

14. *Sciophila popocatepetli* Bellardi.

1859. *popocatepetli,* Bellardi, Saggio di Ditt. Messicana. I. 211.

Female. Length 6 mm., expanse of wings 17 mm. Black, cinereous pollinose; humeri, lateral stripes and obsolete spot at

base of the wing, posterior margin of thorax, pleura and sternum, lutescent; the last two with cinereous; thoracic setæ fine, black, and numerous, but not long, scutellar setæ long and black. Abdominal tergites with lutescent posterior margins. Legs fuscous, darker apically. Wings scarcely grayish, stigma fuscous; cell R_1 square, small, the bounding veins black and thickened. Halteres yellow, knob scarcely infuscated.

Mt. Popocatepetli, Mexico, altitude 3,800 meters. The description is insufficient for positive generic reference, but the numerous thoracic setæ and small cell R_1 suggest *Sciophila* (*Lasiosoma*).

Genus *Paratinia* Mik.

Paratinia. Mik, Verh. Zool.-bot. Ges. Wien, XXIV. 333. 1874.

Head placed low upon the thorax; palpi incurved, 4 jointed, the basal joint very short, the third and fourth cylindrical; eyes oval, somewhat emarginate at the base of the antennæ; ocelli 3 in number, arranged in a transverse line on the front, the middle one but little smaller than the laterals; antennæ projecting forward, 2+14 jointed, the basal joints very small, cupuliform, the flagellar joints cylindrical, sessile, the joints gradually diminishing in length from the base to the tip. Thorax very highly arched, metanotum steep, scutellum small and without long setæ. Abdomen long and slender, 7 segmented. Wing broad, with rather long hairs, especially apically, besides the usual setulæ; costa produced beyond the tip R_{4+5}; subcosta ending in the costa proximad of the middle of the small cell R_1, this cell much longer than broad; Sc_2 (subcostal crossvein) proximad of the small cell R_1; the petiole of the fork of the media about half as long as the anterior branch; the cubitus forks proximad of the fork of the media; anal vein delicate and incomplete (fig. 87). Legs long; tibial setæ very delicate or wanting, the spurs long.

The members of this genus may be distinguished from *Mycomya* by the widely separated ocelli of which the middle one is quite distinct; from the other *Sciophilinæ* they may be separated by the wing venation.

Paratinia recurva n. sp.

Male. Length 5 mm. Head fuscous, transversely oval, somewhat flattened in front, hairy; ocelli 3 in number arranged in a nearly straight transverse line on the broad vertex; mouth

parts fuscous; antennæ much longer than the head and thorax, pale yellow, the joints of the scape nearly spherical, fuscous, first flagellar joint over 5 times as long as wide, the following joints gradually decreasing in length. Thorax ochraceous, with 5 faintly brown longitudinal stripes, the middle one abbreviated behind, the next pair converging posteriorly, the outer pair abbreviated anteriorly; upon these lines are arranged hair-like setæ, those over the base of the wing and on the scutellum longest; pleura, sternum and metanotum brownish, nearly bare. Abdomen brown, posterior markings of the segments yellowish, hairs short, yellow; the abdomen long, slightly thickened apically, hypopygium (fig. 124) small. Coxæ and legs long, yellow, the tibia and tarsi somewhat darker, due mainly to the presence of brownish hairs; no lateral tibial setæ, tarsi sparsely ciliated with very short and fine dark setæ; spurs pale yellow, little less than twice as long as diameter of the tibia at the apex; claws very small, apparently with only a single fine tooth near middle; empodium brushlike; fore metatarsus 0.9, the second fore tarsal joint 0.32 as long as the tibia. Wings hyaline, large, broad, longer than the abdomen, with long hair, especially apically, among the usual minute setulæ; veins yellowish brown; costa (fig. 87) ends at the tip of the wing and beyond the tip of R_{4+5}, which is much arched; cell R_1 about 5 times as long as wide; subcosta ends about opposite the proximal end of the small cell; the subcostal crossvein is nearly the length of the small cell proximad of the apex of the subcosta; media forks slightly proximad of the apical end of the small cell, and the cubitus forks slightly distad of its base; anal vein not strong, ends a little distad of the fork of the cubitus. The figure 87 shows the wing slightly foreshortened. Halteres long, infuscated; knob ovate, its base and tip more yellowish.

One specimen from Old Forge, New York, collected by Professor Needham in August.

6. Genus *Polylepta* Winnertz.

Polylepta, Winnertz, Verh. Zool.-bot. Ges. Wien. XIII. 745. 1863.

Head small, flattened in front, placed low upon the thorax; eyes oval, somewhat emarginate at the base of the antennæ; ocelli 3 in number, placed in a more or less curved line on the

broad front, the middle one smaller than the laterals; palpi incurved, 4 jointed, the first joint very small, the second and third subequal, the last one longer than the others taken together; antennæ projecting forward, somewhat compressed, 2+14 jointed, the basal joints cupuliform, the flagellar joints cylindrical; pubescent. Thorax very short, highly arched; metanotum high, scutellum small; halteres with elongate knob. Abdomen long and slender; in the male somewhat clavate; genitalia small (figs. 118, 121), abdomen in the female cylindrical, constricted at the base, 7 segmented. Legs long, tibiæ with spurs and with lateral setæ. Wings elongate oval, not longer than the abdomen, microscopic hairy. The costa is usually produced beyond the tip of R_{4+5} and nearly or quite reaches the tip of the wing; subcosta ends free or beyond the small cell R_1, which is usually shorter than wide, and noticeably proximad of the middle of the wing; R_{4+5} much curved or undulate, petiole of the media much longer than the R-M crossvein; the cubitus forks proximad of the fork of the media; anal vein incomplete (figs. 88-90). Immature stages unknown.

It seems to me that the characters used to separate *Empalia* from *Polylepta* are scarcely sufficient to give these independent generic rank.

Table of Species.

a. Subcosta ends free.

b. Subcostal crossvein stands on the small cell, which is about twice as long as wide; Mass. 1. *fragilis.*

bb. Subcostal crossvein is far proximad of the small cell; N. H., Ind. (fig. 90). 2. *leptogaster.*

aa. Subcosta ends in the costa.

b. Subcosta ends more than the length of the R-M crossvein distad of the small cell; cubitus forks distad of R_{2+3} (fig. 88). 3. *obediens* n. sp.

bb. Subcosta ends opposite the distal end of the small cell; cubitus forks proximad of the R-M crossvein (fig. 89). 4. *nigellus* n. sp.

For *P. tibialis* Coq. see genus *Empalia.* Walker's species *P. grisea* (5) is not sufficiently well described to place generically. I suspect it is the same as *Sciophila pallipes* Say.

1. *Polylepta fragilis* Loew.

1869. *fragilis*, Loew, Berl. Ent. Zeitschr. XIII. 138.

Female. Length 4 mm. Fuscous black, slightly white pollinose, subopaque. Antennæ fuscous black, the scape and the extreme base of the flagellum yellowish, the first joint of the former fuscous above; palpi yellow; ocelli arranged in a flattened triangle. Coxæ and legs yellow, the tarsi except their bases, fuscous. Wings subhyaline, cinereous fuscous tinted; veins fuscous; costa not produced beyond the tip of R_{4+5}; cell R_1 nearly twice as long as wide, the subcostal crossvein placed at the middle of the anterior margin of this cell; subcosta is strong from the base of the wing to the crossvein, then abruptly interrupted; petiole of the media a little shorter than M_1 but over twice as long as the cell R_1; cubitus forks distad of the R-M crossvein; R_{4+5} noticeably undulating. Halteres pale. Recorded from Massachusetts.

2. *Polylepta leptogaster* Winnertz.

1863. *leptogaster*, Winnertz, Verh. Zool.-bot. Ges. XIII. 746.

Female. Length 4.5 mm. Body brown. Margin of the mouth produced and bordered with hairs. The filiform antennœ 1 1-3 times as long as head and thorax combined, the flagellar joints 3 to 4 times as long as broad. Abdomen very slender, cylindrical, 5 to 6 times as long as the very short thorax, constricted at the base. Coxæ and femora yellow, tibia slightly darker, tarsi pale brown. Fore tarsus 2 1-3 times as long as the tibia, the latter about 1-16 shorter than the metatarsus. Wings hyaline, somewhat cinereous tinged. costa (fig. 90) produced beyond R_{4+5} to the apex of the wing; subcosta ends free proximad of the R-M crossvein; the subcostal crossvein far retracted, cell R_1 trapezoidal, 1½ to 2 times as long as broad; petiole of the media about half as long as M_1; cubitus forks distad of the small cell; anal vein slender, incomplete. Halteres whitish, with fuscous knob. Recorded from N. H. and Indiana.

3. *Polylepta obediens* n. sp.

Male. Length 5 mm. Head black; proboscis reddish; palpi and basal joint of antennæ yellow, face and flagellum fuscous, the intermediate joints of the latter about ¼ longer than the diameter. Mesonotum opaque with 3 dull dark brown conflu-

ent stripes; pleura, metanotum and scutellum brown; humeri, base of scutellum and upper margin of the pleura, yellow, hairs pale. Tergites each with dark brown margin posteriorly which is produced forward on the middle line covering over half of the segment, the whole of the first and the last two mainly, brown. Venter, and anterior part of each tergite mainly yellow, hairs pale; hypopygium as figured (fig. 118). Coxæ and legs together with the hairs yellow, setæ of tibiæ and tarsi black, the longest of the tibial setæ not longer than the diameter of the tibia; trochanters margined with black; (fore legs broken in specimens); proximal fourth of middle tibia distinctly swollen; empodium not prominent; tarsal claws each with a basal tooth. Wings (fig. 88) hyaline, anterior veins brownish, posterior veins yellow, costa produced the length of the R-M crossvein beyond the tip of R_{4+5} but does not quite reach the tip of the wing; the subcosta is produced more than twice the length of the R-M crossvein beyond the distal end of the small cell R_1; the subcostal crossvein is placed beyond the middle of this cell; R_1 is nearly straight, R_{4+5} with a strong sigmal curve; M_1 about 1¾ times as long as the petiole of the media; cubitus forks a little distad of the middle of the petiole of the media; anal vein not strong, incomplete; halteres yellow. One male specimen from Pine Lake, Wisconsin, collected by Prof. W. M. Wheeler, in June; and another from Bedford, Mass.

Female. Like the male but the base of the middle tibia is not swollen; the first and second palpal joints are but little longer than wide; the third and fourth subequal, about four times as long as wide, produced part of costa not quite as long as the R-M crossvein; fore metartarsus is 1 1-6 times as long as the tibia.

One female specimen from Hampton, N. H., collected by Mr. S. A. Shaw. This species differs from the European *undulata* in having a dull mesothorax.

4. *Polylepta nigellus* n. sp.

Male. Length 6 mm. Head black, subshining, second antennal joint yellow, remaining joints fuscous, proboscis and palpi subfuscous; antennæ longer than the thorax, third joint over twice as long as broad. Thorax and abdomen wholly subshining black, except the humeri which are narrowly yellow; setæ black; some of the hairs of abdomen subfuscous. Hypo-

pygium black, inconspicuous (fig. 121). Coxæ and legs yellow, trochanters tipped with black, tarsi brown; setæ of the legs and on the coxæ black; fore metatarsus .7 as long as the tibia; claws each with 2 short teeth; empodium brush-like. Wings (fig. 89) smoky hyaline, yellow basally, distal end of the heavier veins yellowish brown, the remaining veins yellow. Costa almost reaches the tip of the wing and is produced half the length of the R-M crossvein beyond the tip of R_{4+5}; the subcosta ends opposite the distal, the subcostal crossvein opposite the proximal end of the small cell R_1, which is trapezoidal and about as long as broad; M_1 is about 5.5 times as long as the petiole of the media; the sigmoid curve of R_{4+5} is quite noticeable; cubitus forks very slightly proximad of the base of the R-M crossvein; anal vein strong but incomplete. Halteres yellow. One specimen taken by Professor J. M. Aldrich on Mt. Constitution, Orcas, Id. Washington, in July.

5. (?) *Polylepta grisea* Walker.

1848. *grisea,* Walker. List of Diptera. Brit. Museum (*Sciophila*).

Body dark grayish brown, clothed with yellowish hairs; eyes black; palpi tawny; feelers black, ferruginous at the base; legs pale yellow; feet somewhat darker; wings colorless, veins brown; poisers pale yellow. Length of the body 4 mm.; of the wings 8 mm. St. Martin's Falls, Albany River, Hudson Bay.

Recorded also from N. H.

7. Genus *Empalia* Winnertz.

Empalia, Winnertz. Verh. Zool.-bot. Ges. Wien, XIII. 763. 1863.

Head, eyes, antennæ, and legs as with *Sciophila* (*Lasiosoma*). Ocelli 3 in number, the laterals large, the middle one rather small, placed in a nearly straight transverse line, somewhat separated from each other, on the broad front. Palpi 4 jointed, incurved, the first joint small, the second twice as long, the third longer than the first 2 taken together, the fourth filiform, half again as long as the third. Thorax small, oval, highly arched, mesonotum short haired and without setæ; scutellum small. Abdomen 7 segmented, constricted at the base, tapering toward the apex; in the male compressed, in the female cylindrical, the ovipositor ending in 2 small lamellæ; the hairs short and appressed. Wings elongate oval, with rounded base,

shorter or not longer than the abdomen, microscopically hairy. Costa produced far beyond the tip of R_{4+5}, but not reaching the tip of the wing; the subcosta ends over the small cell R_1 curved toward the costa; Sc_2 (subcostal crossvein) proximad of the small cell; petiole of the fork of the media longer than the R-M crossvein; cubitus forks proximad of the fork of the media, but distad of the R-M crossvein; anal vein very short and incomplete (fig. 91). Winnertz reared specimens of this genus from rotten stems of *Carpinus betulus.*

Empalia tibialis Coquillett.

1901. *tibialis,* Coquillett, Proc. U. S. Nat. Mus. XXIII. 596. (*Polylepta*).

Female. Length 5 mm. Head black, the face yellow and rather densely covered with bristly hairs; antennæ brown, the bases yellow, the third joint about twice as long as wide; mouth parts yellow, the penultimate and antepenultimate joints of palpi with leaf-like prolongation at the upper side of their outer ends; thorax polished, yellow, 2 approximated vittæ on the mesonotum and a transverse row of 3 spots on the metanotum dark brown, the hairs and bristles black; scutellum brownish yellow; abdomen yellow, the broad apices of the segments, sometimes crossing the segment in the middle of the dorsum, dark brown; halteres and legs yellow, the tarsi yellowish brown; front tibiæ each with a deep groove before apex of anterior side, extending about one-third length of tibia; wings grayish hyaline, costal cell tinged with yellow, subcostal vein obliterated at its apex, the crossvein slightly before base of radial sector, cubitus forking opposite the cell R_1. N. H., N. J.

This species, originally located in *Polylepta,* I think is more naturally placed with *Empalia.* The straight course of R_{4+5} seems to me to have greater value as a generic character than the incompleteness of the subcosta. See note under the genus *Polylepta.*

8. Genus *Dziedzickia* Johannsen.

Dziedzickia, Johannsen, Genera Insectorum 44. 1909.

Hertwigia, Dziedzicki, Pamietnik Fizyjograf. V. 3. 1885.

Eyes oval, somewhat notched out around the base of the antennæ, widely separated; ocelli 3 in number, the middle one smaller, arranged in a transverse line on top of the head and

widely separated from the eyes; palpi 4 jointed, cylindrical, the first 2 joints short, third joint about half again as long as the second, the fourth slender, sickle shaped, twice as long as the third; antennæ 2+14 jointed, the first one cyathiform, the second cylindrical, the following joints cylindrical, slightly constricted in the middle. The hypopygium stands out, ovate in form, rather large, and not retractile into the abdomen. The tibial setæ are present. The costa extends beyond the tip of R_{4+5}, just reaching the tip of the wing; subcosta ends in R_1 upon the small cell R_1; this cell is usually over twice as long as wide; the media is forked under the distal extremity of this cell; the cubitus forks far proximad of the R-M crossvein, its branches widely separated; the second anal vein is stout and ends far beyond the base of the fork of the cubitus; the third anal vein is rather long but slender (fig. 92).

Table of Species.

a. Wings hyaline.
  b. Petiole of the media about five times as long as the R-M crossvein. 1. *pullata.*
  bb. Petiole of the media about twice as long as the R-M crossvein. 3. N. sp.
aa. Wings dark brown; petiole of the media about equal to the R-M crossvein in length. 2. *fuscipennis.*

1. *Dziedzickia pullata* Coquillett.

1904. *pullata* Coquillett, Invertebrata Pacifica I. 19. (*Neœmpheria*).

Male. Length 3.5 mm. Brown, the first two joints of antennæ, humeri, genitalia and legs, yellow, the latter changing to brownish toward apices of tarsi; antennæ over twice as long as the head and thorax, joints of flagellum very elongate, the third joint of antennæ about 5 times as long as wide; body opaque, the hairs and bristles black; bristles of tibiæ shorter than greatest diameter of the latter; wings hyaline, pubescent, subcostal vein terminates in R_1 slightly before middle of cell R_1, this cell about 3 times as long as wide, R_{4+5} strongly bowed forward, peduncle of cell M_1 about 5 times as long as the R-M crossvein, cubitus at about one-fourth of distance from its base to the R-M crossvein. Stanford University, California.

Two male specimens taken in December by Professor W. M.

Wheeler agree perfectly with Mr. Coquillett's description, to which I may add that the fore metatarsus is about ¾ as long as the tibia; empodium brush-like, shorter than the claws which have 2 teeth each; hypopygium small (fig. 120), and anal vein does not reach the margin (fig. 92).

2. *Dziedzickia fuscipennis* Coquillett.

1905. *fuscipennis*, Coquillett. Journ. N. Y. Ent. Soc. XIII. 67. (*Sciophila*).

Female. Length 6 mm. Distinguished by the dark brown wings. Black, the femora, tibiæ and bases of the tarsi and of the halteres, yellow. Mesonotum polished, its hairs chiefly yellow, the marginal bristles mostly brown, hairs of abdomen chiefly brown. First joint of front tarsi about 2-3 as long as the tibiæ. Wings dark brown, subcosta terminates in R_1 near the middle of the small cell, petiole of cell M_1 subequal in length to the R-M crossvein, cubitus forks far before the R-M crossvein. Length 6 mm. Kaslo, British Columbia.

In this species the cell R_1 is much shorter than in *D. pullata*.

3. *Dziedzickia* n. sp.

There is an unnamed specimen from New Hampshire in the Loew collection at Cambridge with hyaline wings in which the petiole of the media is about twice as long as the R-M crossvein. A note in German apparently written by Loew indicated that he was uncertain of its generic position and therefore refrained from naming it.

9. Genus *Hadroneura* Lundström.

Hadroneura, Lundström, Acta. Soc. Fauna, Flora Fenn. 29, 1907.

Ocelli 3, middle one distinct. Wings (fig. 93) microscopically setulose; costa slightly produced beyond the tip of R_{4+5}; the veins of the anterior parts of the wing unusually thickened; the cell R_1 elongated. The proboscis produced snout-like (fig. 61 in Pt. I). Abdomen 8 segmented. Distinguished from *Dziedickia* by the snout-like proboscis and somewhat heavier wing veins.

Hadroneura kincaidi Coquillett.

1900. *kincaidi,* Coquillett, Proc. Wash. Ac. Science. II. 391. (*Neœmpheria*).

Female. Length 6 mm. Head and its members black, second joint of antennæ yellow, about one-half as long as the third, the 3 ocelli in a transverse row and widely separated from each other; thorax black, opaque, gray pruinose, the mesonotum marked with 4 polished vittæ, scutellum black, the base narrowly yellow, its hairs and those of the thorax golden yellow; abdomen brownish black, slightly polished, its hairs yellowish; coxæ and femora yellow, tibiæ yellowish brown, tarsi dark brown, front tarsi toward their apices, noticeably higher than wide; halteres yellow; wings hyaline, bare, subcostal vein ending in R_1 before middle of cell R_1, the latter about twice as long as wide, anterior fork of media about 10 times as long as its petiole, cubitus forking far before R-M crossvein, the latter shorter than first section of radial sector. Popof Island, Alaska. July.

I have seen this species at the U. S. Nat. Museum, hence the generic reference.

10. Genus *Diomonus* Walker.

Diomonus, Walker, List. Dipt. Brit. Mus. I. 87. 1848.

Large species, over 6 mm. in length. Ocelli 3, widely separated, the middle one but little smaller than the laterals; antennæ 2+14 jointed, first basal joint pilose beneath. Thorax pilose rather than setose. The costa (fig. 94) ends at or but very slightly beyond the tip of R_{4+5} close to the tip of the wing; R_{4+5} slightly bowed back at the middle; cell R_1 less than twice as long as wide; petiole of the media longer than the R-M crossvein; the cubitus forks far proximad of the fork of the media; the setulæ are longer and more dense than in *Mycomya;* the wing is marked with two dark spots. Legs very long, fore metatarsus longer than the tibia; the middle femur of the male bears a blunt spine on the under side; hypopygium small (figs. 123, 125).

Walker's comparison of this genus with *Leptomorphus* is a most happy one, for with the exception of the presence of R_{2+3} in the wing of *Diomonus*, the two are very similar in structural characters.

Table of Species.

a. Fulvous species.

b. Thorax with blackish stripes; hypopygium as figured (fig. 123); abdomen not distinctly fasciate. 1. *bifasciatus.*

bb. Thorax without blackish stripes; abdomen fasciate with brown; hypopygium resembles that of *D. pulcher* (fig. 125). 2. *magnificus.*

aa. Blackish species.

b. Thorax strongly tinged with blue, palpi brownish yellow or yellow.

c. Apical half of antennæ pale yellow; legs mainly black. 3. *nebulosus.*

cc. Antennæ of the male dark brown; legs mainly yellow. 4. *subcæruleus.*

bb. Thorax and abdomen tinged with brown, palpi dusky; hypopygium as figured (fig. 125). 5. *pulcher.*

1. *Diomonus bifasciatus* Say.

1824. *bifasciatus,* Say. Long's Exp. App. 363. (*Sciophila*).

Male. Length 8 to 10 mm. Antennæ brown; basal joints yellow; face yellow, at the base of the antennæ black, remainder of head brownish or blackish; palpi yellowish. Mesonotum yellow with a pair of oblique slender blackish stripes which arise near the anterior margin where they are clubbed, and meet at the base of the scutellum; another wider stripe along the lateral margin which nearly or quite touches the oblique stripe anteriorly; metanotum yellowish brown; lower half of the pleura brownish; hairs yellowish for the most part. Abdomen reddish, segments but slightly if at all darkened apically; hypopygium small (fig. 123). Legs yellow, tarsi slightly darker; fore metatarsus nearly 1.5 times the tibia in length; wings yellowish tinged, with a brown spot covering the small cell and the crossveins, short preapical fascia extending from the tip of R_1 to M_1 and a very faint cloud proximad of Cu_2; anal vein strong but incomplete. Halteres yellow, base of the knob more brownish.

Recorded from Northwest Territory, and N. H. My specimen is from the latter locality.

2. *Diomonus magnificus* n. sp.

Male. Length 8 to 12 mm. Head shining blackish brown, hairs mainly yellow; face strongly produced, yellow, palpi and other mouth parts yellow, scape of the antennæ yellow, the pile on the under side of the first joint yellow; flagellum fuscous, its first joint about 4 times as long as wide. Thorax and abdomen fulvous with yellow hair; the tergites with brownish posterior margins. Legs yellow, tarsi slightly darker; fore metatarsus about 1⅜ times as long as the tibia; all claws with 2 teeth each; empodium represented by a few short setæ. Hypopygium resembling that of *D. pulcher* but the serrate lateral margin of the apex of the appendage marked "a" in figure 125 is much shorter (fig. 114). Wings hyaline, yellow tinged, veins yellowish to yellowish brown, setæ black, of greater length than the diameter of the largest vein, conspicuous; costa extends a very little beyond the tip of R_{4+5}; the subcostal vein ends in the costa about opposite the distal end of the small cell R_1 which is nearly twice as long as wide; the subcostal crossvein is placed but slightly distad of the proximal end of the cell R_1; R_{4+5} is nearly straight and ends before the tip of the wing; petiole of the media is nearly half as long as M_1; the cubitus forks noticeably proximad of the R-M crossvein; anal vein strong but incomplete; a brown spot covers the small cell and the crossvein; a preapical triangular spot the apex of which is produced to the media; a faint cloud follows the course of the petiole of the media and another the course of Cu_2, broadening on the margin. Halteres yellow with more or less infuscated knob.

Female. Similar to the male except for sexual characters. Ithaca, N. Y.; Salineville, Ohio; Mt. Greylock, Mass., (Owen Bryant, collector).

3. *Diomonus nebulosus* Walker.

1848. *nebulosus,* Walker. List. Dipt. Brit. Mus. I. 87.

Body purplish black, shining; palpi tawny; feelers bright yellow, black towards the base, a little longer than the chest, having 15 or 16 joints; first and second joints dark red; mouth dark red; legs black; tips of the hips and thighs at the base pale yellow; hind thighs armed beneath, near their tips, with long, stout spines; knees yellow, shanks with two long spines at their tips; feet reddish brown; wings slightly tawny, with gray tips, and each having a brown spot near the fore border

a little before the middle; veins brown; poisers yellow, with brown tips. Length of body 10 mm.; of the wings 16 mm. St. Martin's Falls, Albany River, Hudson's Bay. A male specimen in the Loew collection at Cambridge, Mass., has the apical half of the antennæ nearly white, sharply contrasting with the basal half.

4. *Diomonus subcæruleus* Coquillett.

1901. *subcæruleus,* Coquillett. Proc. U. S. Nat. Mus. 595.

Male. Length 9 to 13 mm. Black, polished and strongly tinged with blue, the mouth parts brownish yellow, antennæ dark brown, a yellow spot on each prothoracic spiracle; coxæ, femora, and tibiæ, yellow, the tarsi brownish yellow, halteres yellowish brown, the apices and peduncles yellow; hairs of mesonotum short, depressed, yellow, those of the sides, head, and abdomen rather long and black; wings densely hairy, grayish hyaline, a brownish spot at the R-M crossvein and a second beneath apex of R_1; cubitus forking before base of radial sector; cell R_1 about as broad as long; front tibiæ noticeably shorter than the first joint of their tarsi; middle femora each bearing a robust, outwardly directed spine on the under side a short distance before the apex. Apical half of antenna of female light yellow. N. H., Pa., Canada.

5. *Diomonus pulcher,* Johannsen.

1903. *pulcher,* Johannsen, Ent. News. XIV. 14. (*Sciophila*).

This fly differs from *S. subcærulea* Coq. in the following particulars: The thorax has no bluish tinge, the mouth parts are black and not yellow, and the antennæ are gray.

Male. Length 10 mm. Black, polished, with a brownish tinge. Palpi black, basal joint yellowish; face, front and occiput shining black. Antennæ fuscous, with whitish, very short appressed pile. Dorsum of the thorax, scutellum, metanotum and pleura polished black, sparsely covered with very short pale hairs; the prothoracic spiracle, the dorso-pleural suture, and behind the root of the wings slightly yellowish. Abdomen shining black with a brownish tinge, especially at the incisures and the venter. The hairs covering the abdomen are short and pale. Femora and coxæ, and anterior and middle tibiæ are a deep yellow; hind tibiæ are slightly infuscated, all tarsi are brown, darker apically; tips of the posterior femora and of all tibiæ are brown. The middle femora have a short, stout, blunt

spur on the under side near the apex; the fore tibiæ each with one, the middle and hind tibiæ with two spurs. The wing venation resembles that shown in figure 94, the forking of cubitus being proximad of the crossvein, the subcostal crossvein is near the base of the small cell; R_1 is nearly straight, and R_{4+5} is slightly curved forward so that the distal third is parallel with R_1 and ends more than the length of the R-M crossvein before the tip of the wing. The cell R_1 is about 1.5 times as long as broad. The wings are short haired; the veins are yellow excepting the crossveins which are dark brown. Covering the crossvein is a pale brown cloud, and near the apex below R_1 is another. The halteres are a dusky yellow or brown, the base of the peduncle is yellow. Described from one specimen taken June, 1901, at Axton, N. Y.

I have also seen a specimen from Hampton, N. H., collected by Mr. S. A. Shaw. To the above description I may add that the three ocelli are in a transverse row on the front; the fore metatarsus is nearly 1.4 times as long as the tibia in the male, a little less in the female; claws all with two basal teeth; hypopygium as shown in figure 125.

A female specimen taken by Mr. Shaw at the same place and time differs in having the intermediate segments of the abdomen with a reddish tinge; in one wing wholly lacking R_{2+3}, and but feebly indicated in the other. This specimen would have been classified with *Leptomorphus* owing to the defective venation had it not been accompanied by the male.

11. Genus *Neœmpheria* Osten Sacken.

Neœmpheria, Osten Sacken, Catl. Dipt. 9, 1878.

Empheria, Winnertz, Verh. Zool.-bot. Ges. Wien. XIII. 707. 1863.

Ocelli two, large, closely approximate, if a median one is present it is exceedingly minute; eyes usually circular, but little if any emarginate; antennæ somewhat compressed; no spur on middle coxæ of males; costa (fig. 95-100) usually produced more or less beyond the apex of R_{4+5} which usually does not reach the tip of the wing; a conspicuous longitudinal fold lies between the radial sector and the media; wing with fasciæ or spots. Thorax somewhat setose; hypopygium various. In other respects like *Mycomya*.

In "Genera Insectorum" I united this with *Mycomya,* treating it as a subgenus, for the reason that I did not consider the fasciate wings of generic value, none of the other characters being uniformly trustworthy. I restore it because I now believe that in addition to the markings on the wing there are sufficient structural characters which combined mark the genus even though none of them can independently be relied upon. The hypopygia while apparently differing from that of *Mycomya* are so varied and so complex in both genera that I have not yet found a single character which could be used to separate the two.

Table of Species.

a. Media forks distad of the small cell R_1 which is not more than 3 times as long as wide.

b. Extremity of the wing not hyaline.

c. Tergites of the first, third and fifth, and larger part of sixth, segments dark brown; a spot near anterior margin of second and fourth segments and produced in a median line, remaining parts and venter, yellow; entire dorsum sometimes dark brown. Length 4 mm. (fig. 98).
1. *macularis* n. sp.

cc. Intermediate abdominal segments each with a pair of spots near posterior margin, sometimes obsolete; length 5½ mm. 2. *didyma.*

bb. Wing with broad subapical fascia, the apex of the wing clear hyaline.

c. Spot which covers the R-M crossvein extends nearly to the posterior wing margin; small cell R_1 over twice as long as wide; apex of subcosta evanescent.

d. Subcostal crossvein is situated proximad of the base of the small cell R_1; (fig. 95).
3. *nepticula.*

dd. Subcostal crossvein is slightly distad of the base of the small cell R_1; (fig. 96).
4. *impatiens* n. sp.

cc. The spot which covers the small cell and the crossvein does not reach the base of the fork of the cubitus; the subcostal crossvein is placed distad

of the middle of cell R_1; subcosta ends in the costa (fig. 99). 5. *indulgens* n. sp.

aa. Media forks proximad of the apex of the cell R_1 which is more than 3 times as long as wide.

b. Apex of cells R_{4+5} and M_1 nearly hyaline. St. Vincent Isl., W. I. 6. *maculipennis.*

bb. Apex of cells R_{4+5} and M_1 broadly brown clouded.

c. The brown cloud covering R_{2+3} produced across the media; subcostal crossvein proximad of the apex of the very oblique basal section of the radial sector (fig. 100). 7. *illustris* n. sp.

cc. The brown cloud covering R_{2+3} not produced; a brown cloud behind Cu_2; abdominal segments bimaculate (fig. 97). 8. *balioptera.*

1. *Neœmpheria macularis* n. sp.

Male. Length 4 mm. Head and antennæ yellow, the latter slightly darker apically; palpi dark brown, ocellar tubercle black; second joint of scape with a black seta on dorsal side near apex, the basal joints of flagellum over twice as long as wide, the apical end of each joint of flagellum except the first with setulæ more erect than on the remainder of the joint. The pleura, sternum, scutellum, and lateral margin of mesonotum pale yellow; the dorsum pale brown, margined with darker brown, on the paler portion are 2 fine longitudinal lines which converge and meet in the vertex of an elongate triangular brown spot just cephalad of the scutellum; metanotum brown. The lateral margins of the mesonotum are provided with black setæ, more conspicuous at the base of the wings, also a few on anterior margin and just cephalad of scutellum, a few small ones on the dorsum, two longer ones on the scutellum. Tergites of the first, third, fifth and a larger part of the sixth segment of the abdomen dark brown; a spot near the anterior margin of the second and fourth and produced in a median line; the remaining parts, venter, and hypopygium (fig. 130) yellow. Legs yellow, tarsi more dusky, fore metatarsus is over 0.9 as long as the tibia; setæ of fore tibiæ few and short, those of middle and hind pairs more numerous, the longest about as long as the diameter of the tibia; spurs black; claws with one tooth each. Wings (fig. 98) hyaline, with a spot covering the small cell and the R-M crossvein but not reaching the cubitus, another cover-

ing the apex of the wing from the tip of R_1 to the tip of Cu_1, apex without hyaline spot; subcosta ends in costa opposite apex of small cell R_1; subcostal crossvein a little before the middle of this cell, the latter but little longer than broad; costa noticeably produced beyond R_{4+5}; petiole of the media about half as long as M_1; the cubitus forks under the base of the R-M crossvein. Halteres yellow. Ithaca, N. Y.

A female specimen from Montreal differs in having the top of the head pale brownish, no fine brown lines on the mesonotum, and the brown of the second and fourth segments of the abdomen more extended, produced into a fine line to the posterior margin; fore metatarsus and tibia subequal.

2. *Neœmpheria didyma* Loew.

1869. *didyma* Loew, Berl. Ent. Zeitschr. XIII. 136 (*Empheria*).
1866. *bimaculata* Loew, Berl. Ent. Zeitschr. X. 6 (*Sciophila*).

Female. Length 5.5 mm. Yellowish. Flagellum of the antennæ fuscous black, palpi black. The first segment of the abdomen fuscous black excepting the sides and posterior margin, the intermediate segments yellow each with 2 transverse black spots on the posterior margin. Legs yellow, tarsi blackish toward their tips. Wings with cinereous tinge, toward the costa more yellowish; the costa produced slightly beyond R_{4+5}; subcostal crossvein at or distad of the middle of cell R_1, this cell of medium size and much shorter than the petiole of the media; the first section of the radial sector and the R-M crossvein covered by a cinereous fuscous spot, apex of the wing and apex of the posterior angle widely cinereous fuscous. Halteres yellow. Recorded from Canada.

3. *Neœmpheria nepticula* Loew.

1869. *nepticula* Loew, Berl. Ent. Zeitschr. XIII. 137. (*Empheria*).

Male and female. Length 2.5 mm. Pale yellow, palpi black, vertex and sometimes the mesonotum dusky yellow; the first, third and fifth abdominal segments black, the anterior half of the second blackish, the sides of the first segment in mature or the whole of the segment in immature specimens yellow. Wings (fig. 95) subhyaline, lightly cinerescent; costa produced far beyond R_{4+5}, subcosta is paler and more slender than the other veins, becomes obsolete at the apex; subcostal vein is

placed near the tip of the costa and slightly proximad of the base of the cell R_1, petiole of the media 3 times as long as this cell; a fuscous cinereous fascia extends from R_1 nearly to the posterior wing margin where it becomes very faint; apical third of the wing fuscous cinereous, becoming paler at the apex so that the mark appears like a subapical fascia. Fore metatarsus and tibia subequal. Length of wing 2.2 mm. Halteres pale. Recorded from Georgia and New Jersey. I have also seen a specimen from North Carolina.

4. *Neœmpheria impatiens* n. sp.

Related to the foregoing but differs in being larger, in having the subcostal crossvein slightly distad of the base of the cell R_1 and in having the petiole of the media about twice as long as this cell.

Female. Length 4.5 mm. Head yellow; ocellar spot and palpi black, labellæ tipped with brown; occiput tinged with brown; a transverse row of 6 or 8, black, procumbent setæ just behind the ocelli. Mesonotum yellow, median and lateral stripes pale brown, the latter more distinct at base of wing; scutellum and mesonotum pale brown, pleura yellow with a longitudinal stripe over the middle and hind coxæ; setæ black, most conspicuous at the base of the wing and in front of scutellum, 2 long scutellar setæ. Dorsum of the first, second, third, fifth, and sixth segments dark brown; the posterior and lateral margins of these segments, the venter, ovipositor, and remaining segments, yellow. The dark coloring on the dorsum of the third and fifth segments rather more extended than on the others, covering all but very narrow lateral and posterior margins, ovipositor slender (fig. 131). Legs yellow, setæ and setulæ black, tarsi appear more dusky. Middle and hind tibiæ each with several rows of about 8 short black setæ in each row; each claw with a tooth near base; fore metatarsus and tibia subequal in length. Wings (fig. 96) hyaline, each with 2 broad brown bands, the first from costal cell covering cell R_1 and extending to beyond the fork of the cubitus, gradually fading out toward posterior margin; the second, subapical, leaving the apices of costa and R_{4+5} clear, extending to anterior branch of cubitus. Costa prolonged beyond apex of R_{4+5} and not reaching tip of wing; the subcostal crossvein joins the radius slightly distad of the base of cell R_1, the subcosta extending a little beyond this,

gradually becoming fainter toward the tip and seemingly joining the costa; cell R_1 over twice as long as wide; petiole of the media about twice as long as the small cell; cubitus forks slightly distad of base of the R-M crossvein, the latter rather long and much curved. Halteres yellow. Kingston, R. I. Collected in August by Professor John Barlow.

A specimen from the Valley of the Black Mts., N. C., collected by Mr. Wm. Beutenmuller in July, and a specimen from Knoxville, Tenn., differ only in lacking the bar over the base of the coxæ and in having thorax a little more deeply yellow.

5. *Neœmpheria indulgens* n. sp.

Female. Length 5 mm. Head yellow; palpi, ocellar spot and setæ black; flagellum of antennæ infuscated, intermediate joints about as long as wide, second joint of scape with a long slender black seta on dorsal surface. Thorax wholly yellow, mesonotum with 5 longitudinal lines of small black setæ besides the irregular lateral lines of longer setæ which extend to base of wing, humeri with a number, scutellum with 2 long setæ. Abdomen yellow, dorsum of second, third and fifth segments with large dark brown subtriangular spot; ovipositor yellow. Legs yellow; fore metatarsus about 0.85 times as long as the fore tibia; middle and hind tibiæ with short black setæ arranged in several longitudinal rows of 8 or 10 setæ in each; claws each with 2 basal teeth. Wings (fig. 99) hyaline, a brown spot covering the small cell and the R-M crossvein but not reaching the fork of the cubitus, a larger faint cloud posterior to Cu_2 and a subapical fascia from the tip of R_1 to the anterior branch of the cubitus, but leaving the tips of the costa, R_{4+5} and the media clear; veins yellowish brown; subcosta reaches the costa slightly distad of the tip of the cell R_1; the subcostal crossvein on the middle of the small cell which is but little longer than wide; petiole of the media is about half as long as Cu_2; the cubitus forks slightly proximad of the base of the crossvein; anal vein long but not reaching the margin. Halteres yellow. Taken in July at Montreal, Canada.

Male. Two specimens from Ithaca, N. Y., have indications of four ferruginous thoracic stripes, but are otherwise similar. The hypopygium is as shown in figure 128.

A specimen from Black Mts., N. C., taken by Mr. Beutenmuller, is similar to the Ithaca specimen but the subcostal crossvein is placed at the apex of the cell R_1.

6. *Neoempheria maculipennis* Williston.

1896. *maculipennis* Williston, Trans. Ent. Soc. London. 262.

Male. Length 5 mm. Antennæ about as long as the head and thorax together; the basal joints light yellow, the remainder with a brownish tinge. Palpi brown; front and face yellow; mesonotum, except the lateral margins, light brown, with black hair and bristles; indistinctly striped; moderately shining. Pleura, coxæ and femora light yellow. Scutellum, except at its base, light yellow, and with two bristles on its margin. Abdomen light yellow, each segment with a large black or brown spot, not reaching the hind margin. Tibiæ and tarsi yellow, but appearing blackish from the abundant, short, black hair; front tarsi more than twice the length of their tibiæ. Wings nearly hyaline, with the following markings: the tip of the subcostal cell and the cell R_{2+3} beyond R_{2+3}, and the proximal end of the cell R_{4+5}, brown; a more distinct brown spot clouding the subcostal crossvein, the basal section of the radial sector, the base of the cell R_{4+5}, and, more diffusely, along the posterior branch of the media, to connect with a spot running from the cell R_{4+5} into the hindermost posterior cell; a smaller brownish spot in the axillary angle; costal and subcostal cells yellowish; costa produced beyond the tip of R_{4+5}; R_{2+3} situated a little beyond the furcation of the media. 1,000 ft., St. Vincent Isl., W. I.

7. *Neoempheria illustris* n. sp.

Male and female. Length 5 mm. Resembles *N. balioptera* in possessing an elongate cell R_1, but differs in the position of the subcostal crossvein and in coloring; from *N. maculipennis* it differs in having the apex of the wing more widely brown.

Head yellow, ocellar spot and palpi black; antennæ yellow, intermediate joints little if any longer than broad, 2 or 3 black setæ at the apex of the second basal joint. Thorax yellow, mesonotum with 5 brown stripes, scutellum with a brown spot on the middle behind the suture, metanotum brown, setæ black, those on the humeri, at the base of the wing and the 2 on the scutellum most prominent. Abdomen yellow, the dorsum of segments 1, 3, 5 and 6 except at the incisures and a spot of greater or lesser extent at the base of each of segments 2 and 4, brown. The brown on the third and fifth extends to the lateral margins; hypopygium as figured (figs. 126, 127). Legs

yellow; setulæ of tibiæ and tarsi make these appear more dusky; setæ of middle and hind tibiæ shorter than diameter of these members; each claw with a tooth on the under side near the middle and 2 or 3 shorter tubercles near the base; fore metatarsus over 0.9 as long as the tibia in the male; subequal in the female. Wings (fig. 100) hyaline, veins brown; a brown cloud covers the subcostal crossvein and base of the radial sector; another cloud covers R_{2+3}, broadens posteriorly crossing the posterior radial cell, then follows the posterior branch of the media and merges into the brown which covers the entire apex of the wing from the tip of R_1 to beyond Cu_1; posterior to Cu_2 there is a faint indication of another cloud; the costa is distinctly produced beyond the apex of R_{4+5}; the subcostal crossvein joins R_1 opposite the apex of the subcosta and before the apex of the very oblique first section of the radial sector; the media forks distinctly proximad of R_{2+3}; the cubitus forks about opposite the base of the radial sector; anal vein distinct but incomplete. Halteres yellow. Ithaca, N. Y.

8. *Neœmpheria balioptera* Loew.

1869. *balioptera,* Loew. Berl. Ent. Zeitschr. XIII. 136.

Female. Length 6.2 mm. Yellowish or dusky yellowish; body pile black. Head a little darker; antennæ reddish yellow, apically blackish; palpi black. The posterior margins of the first abdominal segment with dark brown fascia and a large spot near each latero-posterior margin of segments 2, 3 and 4. In paler specimens the spots are pale brown. Hypopygium robust (fig. 129). Legs yellow, tibiæ somewhat darker, tarsi blackish, fore metatarsus ⅞ as long as the tibia; tarsal claws each with 2 teeth. Wings (fig. 97) yellowish with a cinereous tinge, toward the costa more deeply yellowish; costa slightly produced beyond R_{4+5}; the subcostal crossvein is placed near the base of the cell R_1, this cell is large and longer than the petiole of the media; a fuscous spot extends from the subcosta, covering the subcostal crossvein, the basal section of the radial sector, the R-M crossvein and following the course of the petiole of the media; R_{2+3} is covered by a small fuscous spot; apex of the wing from the tip of R_1 to the tip of Cu_1 fuscous as well as the part behind Cu_2, apically somewhat more faint.

This species has been recorded from Illinois and New Jersey. I have seen specimens from Ithaca, N. Y., and Chicago, Ill.

12. Genus *Mycomya* Rondani.

Mycomya, Rondani, Dipt. Ital. Prodr. I. 194. 1856.
Sciophila, Meigen (part.) Syst. Beschr. I. 245. 30. 1818.
Sciophila, Winnertz. Verh. Zool.-bot. Ges. Wien. XIII. 707. 1863.

The name *Mycomya* is used here in the sense of *Sciophila* of Winnertz over which it has priority. *Neœmpheria* which I considered as a subgenus in the "Genera Insectorum" I here restore to its original position for reasons already mentioned.

Head small, flattened in front, placed low upon the thorax; eyes elongate oval, usually emarginate at the base of the antennæ; ocelli placed close together, the laterals large, the median very minute or wholly wanting; proboscis short, palpi incurved, 4 jointed, the first joint very small, the fourth longest; antennæ 2+14 jointed, the joints of the scape setose at the tip, flagellar joints cylindrical, pubescent. Thorax highly arched, ovate, scutellum small, semicircular in outline. Abdomen slender, with 7 visible segments, constricted at the base; somewhat clavate, particularly in the male; hypopygium rather small (figs. 132-147); ovipositor short, terminating in 2 small lamellæ (fig. 139). Coxæ long, setose; legs long and slender, femora ciliated on flexor surface; tibiæ with lateral setæ. Wing (figs. 101-106) microscopically setulose, somewhat projecting beyond the tip of the abdomen. The costa usually ends at the tip of the wing where it meets R_{4+5} but usually not produced beyond it; the subcosta may end in the costa, in R_1 or end free; the subcostal crossvein at or distad of the base of cell R_1; cubitus forks proximad of the media; the anal veins incomplete and usually rather short. The larvæ have been found in fungi and in decaying wood.

Table of Species.

Males.

a. Thorax and abdomen nearly wholly dark; western species.
  b. Subcosta ends in R_1; cubitus forks distad of the R-M crossvein. 1. *littoralis,* var. *frequens.* n. var.
  bb. Subcosta ends in the costa; cubitus forks proximad of the R-M crossvein.
    c. Middle coxæ with spurs; petiole of media about half as long as M_1. 4. *calcarata.*
    cc. Middle coxæ without spurs; petiole of media about six times as long as R-M crossvein. 5. *simplex.*

aa. Thorax or abdomen or both with considerable yellow.
- b. Hypopygium with two slender, slightly curved, dorsal processes (fig. 147); fore metatarsus shorter than its tibia, no coxal spur; mesonotum vittate. 6. *Mycomya sp.*
- bb. Hypopygium not as described above.
  - c. Subcosta does not end in the costa.
    - d. Subcosta ends in R_1. 1. *littoralis.*
    - dd. Subcosta ends free.
      - e. Dorsum of thorax black; posterior margin of the abdominal sclerites black. 2. *obtruncata.*
      - ee. Dorsum of thorax vittate; margins of abdominal sclerites yellow. 3. *sequax* n. sp.
  - cc. Subcosta ends in the costa.
    - d. Posterior margin of tergites distinctly brown or black; anterior part yellow.
      - e. Petiole of media equal or longer than M_2.
        - f. Dorsum of thorax with distinct black markings; fore metatarsus shorter than tibia; subcostal crossvein at the middle of the cell R_1.
          - g. Mesonotum with 2 oblique lines which meet at scutellum; a median line and 2 elongate lateral spots over the base of the wing. 7. *obliqua.*
          - gg. Mesonotum with 3 confluent or subconfluent dusky stripes. 8. *tantilla.*
        - ff. Mesonotum with faint markings. 9. *nigracauda.*
      - ee. Petiole of media shorter than M_2.
        - f. Middle coxæ without spurs; fore metatarsus shorter than its tibiæ; median vitta of thorax usually paler than the laterals. 10. *brevivittata.*
        - ff. Middle coxæ with spurs; fore metatarsus equal or longer than its tibia.
          - g. Dorsum of abdomen with longitudinal black stripe; fore metatarsus equal to tibia in length; subcostal crossvein proximad of middle of cell R_1; length 4.5 mm.; hypopygium as figured (fig. 135). 11. *marginalis* n. sp.

gg. Posterior margins of tergites black; fore metatarsus longer than its tibia; hypopygium as figured (figs. 132, 136).
12. *imitans* n. sp.

dd. Posterior margins of tergites yellow, or abdominal segments unicolored, yellow or brown.

e. Abdomen with 2 or 3 spots on each segment; petiole of media shorter than M_2.
13. *biseriata.*

ee. Abdomen not so marked.

f. Dorsum of abdomen with a median row of large spots which may be confluent, forming a dorsal stripe; middle coxæ with spurs; fore metatarsus equal or longer than the tibia.

g. Fore metatarsus 1-10 longer than the tibia; hypopygium as figured (fig. 137); length 6.5 mm. 14. *maxima* n. sp.

gg. Fore metatarsus subequal to tibia in length; hypopygium as figured (fig. 135); length 4.5 mm.
11. *marginalis* n. sp.

ff. Tergites each with a more or less yellow posterior margin; or wholly of one color.

g. Fore metatarsus is longer than the tibia.

h. Abdomen brown, sclerites faintly yellow margined posteriorly; length 4 mm.; hypopygium as figured (fig. 138); cell R_1 2.5 times as long as wide and half as long as the petiole of the media. 15. *sigma* n. sp.

hh. Abdomen not so marked.

i. Subcostal crossvein proximad of the middle of cell R_1; only the posterior margins of tergites yellow; length 6.5 mm. 14. *maxima* n. sp.

ii. Subcostal crossvein is near middle of the cell R_1; length 3.5 mm.; both anterior and posterior margins of tergites yellow. 17. *hirticollis.*

gg. Fore metatarsus shorter than its tibia.
h. Neither thorax nor abdomen with distinct dark markings; cubitus forks under or distad of the R-M crossvein; length 3 mm. St. Vincent Isl.
18. *meridionalis* n. n.
hh. Not as above.
i. Length 5 mm. or more.
j. Thorax and scutellum yellow; cubitus forks far before the base of the radial sector.
19. *flavohirta.*
jj. Thorax with three subconfluent black stripes; cubitus forks under the R-M crossvein.
20. *mendax* n. sp.
ii. Length 3.5 mm. or less.
j. Subcostal crossvein proximad of middle of cell R_1.
16. *appendiculata.*
jj. Subcostal crossvein at middle of cell R_1. 17. *hirticollis.*

Females.

a. Subcosta does not end in the costa.
b. Subcosta ends in a stump; petiole of the media is shorter than M_2; thorax yellow with dark brown stripes; cubitus forks under the R-M crossvein.
c. Length 6.5 mm. 14. *maxima* n. sp.
cc. Length 3.5 mm. 3. *sequax* n. sp.
bb. Subcosta ends upon R_1; petiole of the media is longer than M_2; length 3 to 4 mm.
c. Thorax and abdomen mainly dark. California.
1. *littoralis* var. *frequens* n. var.
cc. Thorax and abdomen largely yellow. 1. *littoralis.*
aa. Subcosta ends in the costa.
b. Posterior margin of each tergite black or brown.
c. Cubitus forks distad of the R-M crossvein; fore metatarsus shorter than the tibia; length 3 mm.
d. Subcostal crossvein near middle of small cell R_1.
8. *tantilla.*

dd. Subcostal crossvein near base of cell R_1.
21. *nugatoria* n. sp.

cc. Cubitus forks under or proximad of R-M crossvein.

d. Mesonotum with 5 elongate spots or stripes, the median and the oblique first laterals meeting in front of the scutellum; petiole of media is equal or greater than M_2. 7. *obliqua.*

dd. Mesonotum with 3 more or less distinct stripes; the subcostal crossvein at or distad of the middle of cell R_1.

e. Petiole of the media about 1.5 times as long as cell R_1; middle thoracic stripe subobsolete.
22. *onusta.*

ee. Petiole of the media about twice as long as the cell R_1; middle thoracic stripe distinct.
12. *imitans* n. sp.

bb. Posterior margin of each tergite yellow, or abdomen is uniformly colored.

c. Three elongate spots on each tergite. 13. *biseriata.*

cc. Tergites marked otherwise.

d. Fore metatarsus equal or shorter than its tibia.

e. Length 3.5 mm. 17. *hirticollis.*

ee. Length 5 to 6 mm.; petiole of media is shorter than M_2. 20. *mendax* n. sp. and varieties.

f. Cubitus forks distad of the R-M crossvein and the subcostal crossvein is placed proximad of the middle of cell R_1.
20. var. a. of *mendax* n. sp.

ff. Cubitus forks under or proximad of R-M crossvein, and subcostal crossvein is placed at or distad of the middle of cell R_1.

g. Fore metatarsus is 0.9 as long as its tibia; the cubitus forks under the R-M crossvein; the subcostal crossvein is near the middle of cell R_1. 20. *mendax* n. sp.

gg. Fore metatarsus is 0.8 as long as its tibia; the cubitus forks proximad of the R-M crossvein; the subcostal crossvein is distad of the middle of cell R_1.
20. var. b. of *mendax* n. sp.

dd. Fore metatarsus is longer than its tibia.

e. Thorax black with yellow humeri; petiole of media about 6 times as long as cell R_1; length 4 to 6 mm. 5. *simplex.*

ee. Thorax largely yellow.

f. Subcostal crossvein is placed proximad or at the middle of cell R_1.

g. Length 3.5 mm. "Both anterior and posterior margins of each tergite, pale." 17. *hirticollis.*

gg. Length 4 to 5.5 mm.

h. Fore metatarsus about 1-12 longer than its tibia.

i. Subcostal crossvein is placed at middle of cell R_1. 23. *recurva* n. sp.

ii. Subcostal crossvein proximad of middle of this cell.

23. *recurva* var. *chloratica* n. var.

h. Fore metatarsus over 1-5 longer than its tibia. 24. *incompta* n. sp.

ff. Subcostal crossvein is distad of the middle of the small cell R_1; "apex of R_{2+3} turned toward the base of wing"; length 6 mm.; Colorado. 25. *angulata.*

1. *Mycomya littoralis* Say.

1824. *littoralis.* Say, Long's Exp. St. Peter's River. App. 361. (*Sciophila*).

Male. Length 3.5 mm. Vertex fuscous, ocellar spot, black, eye margin and occiput subfuscous to yellowish; face, palpi, mouth parts and scape yellow; the flagellum fuscous, except sometimes 1 or 2 basal joints; third joint nearly twice as long as wide; antennal hairs pale, setæ of the head, black. Thorax yellow, 3 dark brown stripes on mesonotum, the laterals abbreviated anteriorly, the middle one prolonged both anteriorly and posteriorly; anterior margin of scutellum and a spot on metanotum, brownish; the 4 scutellar setæ and the setæ of the anterior and lateral margins of the thorax, black; the smaller setæ of the dorsum, arranged in 3 rows of 2 lines each ,are also black, but the finer hairs on the dorsum and 2 longer ones on the posterior margin are pale yellow. Abdomen yellow, the dorsum

of the first and sixth in large part, and narrow posterior margins of the remaining segments dark brown, usually also a brown spot on the anterior margin which is more or less prolonged along the median line; abdominal hairs pale. Hypopygium (similar to fig. 144) yellow, much resembling that of *M. penicillata* Dzied.; the inferior forceps with broad margin and strongly ciliate; the superior forceps (fig. 145) widened spatulate, the margin with one long and slender seta and several shorter, stout, blunt spines, and arising from near the base a curved spatulate and setose process projecting laterally; the intermediate appendages are much prolonged, slender, doubly curved; the caudal margin of the ventral sclerite is bilobed and pectinate. The legs are yellow and quite slender, the fore metatarsus is over ¾ as long as the tibia; the larger setæ of hind tibiæ but little longer than the diameter of this member. Wings (fig. 101) hyaline, slightly yellow tinged; subcosta ends in R_1 usually proximad though sometimes distad of the middle of cell R_1; variable occasionally even in the two wings of the same individual, small cell about twice as long as broad measured along R_1; petiole of the media longer than M_2; R_{4+5} ends very slightly before the tip of the wing; cubitus forks distad of the R-M crossvein. Length of wing is 3 mm. and is 3 times as long as the fore metatarsus. Halteres yellow. Ithaca and Old Forge, N. Y.; Price Co., Wisconsin; July and August.

Female. Similar to the male but the wing is slightly larger and the ratio of fore metatarsus to tibia is smaller. In immature specimens the stripes on mesonotum may be pale brown, or the lateral stripe yellowish brown and the median stripe darker.

Var. *frequens* n. var.

Male and female. Similar to the typical form in structure of wing and legs but differs in having head including mouth parts, thorax (except humeral spot and a spot at base of the wings), and abdomen dark brown; coxæ yellowish brown; legs tinged with brown; and inner lobe of superior forceps crescent shape (fig. 144a, edge view).

Berkeley (Wheeler); Alum Rock Park, San Jose; (Aldrich); Felton, St. Cruz Mts. (J. C. Bradley); California, March, April, May.

2. *Mycomya obtruncata* Loew.

1869 *obtruncata,* Loew, Berl. Ent. Zeitschr. XIII. 139. (*Sciophila*).

Male. Length 3.3 mm. Head fuscous black, lower half of the face paler; antennæ fuscous black, scape as well as the basal joint of the flagellum yellowish; palpi yellowish. Thorax fuscous black, with black pile, humeri widely yellowish, the lateral margins whitish or pale yellowish; scutellum fuscous black; upper half of the pleura dusky yellowish, lower half fuscous. First, sixth and seventh abdominal segments wholly black, the remaining segments yellowish, except for the black apical fasciæ of each; hypopygium small, yellowish. Pile of the abdomen black. Coxæ and legs pale yellow, tarsi fuscous. Wings cinereous tinged, veins fuscous; subcostal vein ends free a little beyond the subcostal crossvein which is placed slightly proximad of the middle of the cell R_1; the petiole of the media and its fork subequal in length; the cubitus forks distad of the R-M crossvein. Length of wing 3.5 mm. Halteres pale. Recorded from District of Columbia.

3. *Mycomya sequax* n. sp.

Male. Length 3.5 mm. Slender; head and antennæ brown; ocellar spot black; occiput, face, palpi and base of antennæ yellow; with setæ black; intermediate antennal joints about 1.5 times as long as wide. Thorax yellow, the 3 dorsal stripes and metanotum pale brown with wide yellow lateral and posterior margins. Hairs pale. The last abdominal segment more prominent than the small and inconspicuous hypopygium (fig. 146). yellow, resembling that of *ocultans* Winn., as figured by Dziedzicki. Legs long and slender, yellow, fore metatarsus over 1.25 times as long as its tibia; spur of intermediate coxæ slender and about half as long as the fore tibia; setæ of hind tibia not twice as long as the diameter of this member. Wings (fig. 103) hyaline, yellow tinged, large veins brownish yellow, subcosta ends in a stump a little beyond the subcostal crossvein which is placed very near the base of the cell R_1, the latter is large, over twice as long as wide; R_{4+5} ends at the tip of the wing; the petiole of the media is equal to M_2 in length, the cubitus forks slightly distad of the R-M crossvein; the wing is 3.5 mm. in length which is 1.7 times as long as the fore metatarsus. Halteres yellow.

Female. Similar to the male but the fore metatarsus is 1 1-6 times the tibia in length, and the subcostal crossvein is near the middle of the small cell R_1 which is not quite twice as long as wide; no coxal spurs. Both sexes from Ithaca, N. Y., taken in July.

4. *Mycomya calcarata* Coquillett.

1904. *calcarata,* Coquillett. Invertebrata Pacifica I. 19. (*Sciophila*).

Male. Length 4 mm. Black, the extreme base of third joint of antennæ, halteres, genitalia largely, femora, tibiæ and base of first joint of tarsi yellow; third joint of antennæ nearly 3 times as long as broad, the following joints longer than wide; body opaque, gray pruinose, mesonotum marked with 3 black vittæ, the middle one divided medially by a gray line, hairs and bristles of thorax black; middle coxæ bearing at apex of front side a forwardly directed, 2-pointed spur which is almost half as long as the coxæ; bristles of tibiæ shorter than the greatest diameter of the latter; fore metatarsus slightly shorter than its tibia; wings pubescent, hyaline, subcostal vein terminates near middle of cell R_1, the subcostal crossvein slightly before the middle of this cell, the latter about 1.5 times as long as broad, R_1 and R_{4+5} veins strongly bowed forward, peduncle of cell M_1 about half as long as M_1, cubitus forks slightly before R-M crossvein. California.

5. *Mycomya simplex* Coquillett.

1905. *simplex,* Coquillett, Journ. N. Y. Ent. Soc. XIII. 67 (*Sciophila*).

Male and female. Length 4 to 6 mm. Near *calcarata* but the middle coxæ are without spurs, etc. Black, the mouth parts, bases of antennæ, a humeral spot, base of venter, halteres, coxæ, femora, tibiæ, bases of tarsi and hind borders of abdominal segments of the female, yellow, hind coxæ usually marked with brown. Antennæ elongate, the joints beyond the second over twice as long as wide. Body opaque, densely gray pruinose, the hairs black. First joint of front tarsi subequal or slightly longer than the tibiæ. Wings hyaline, subcostal vein ends in costa near or beyond middle of cell R_1, petiole of media cell about 6 times as long as the small crossvein, cubitus forks slightly before the small crossvein. British Columbia, July and August.

6. *Mycomya* sp.

Male. Length about 3.5 mm. Head yellowish brown, occiput, face and palpi yellow; ocellar spot distinct, blackish; setæ black. Thorax yellow, 3 dorsal stripes dark brown, the lateral abbreviated anteriorly; scutellum and mesonotum pale brown; abdomen defective, tergites apparently mainly brown with yellow along lateral margin; hypopygium as figured (fig. 147). Coxæ yellow, middle pair without spur; fore metatarsus .55 times as long as its tibia. Antennæ, wings and middle and hind legs missing. A specimen taken by Professor Wheeler, in August, in Price Co., Wis.

7. *Mycomya obliqua* Say.

1824. *obliqua*, Say, Long's Exped. St. Peter's River, App. 363. (*Sciophila*).

Male. Length 3.5 mm. Head black, face, mouth parts and basal joints of antennæ yellow; flagellum fuscous. Thorax yellow with two oblique brown stripes which meet at the scutellar suture; a median stripe between these and produced to the collar usually paler brown, and two lateral darker brown stripes abbreviated anteriorly; scutellum except at the suture and dorsum of metanotum usually dark brown; a few fine pale hairs on the dorsum; setæ black. Abdomen yellow, the first, sixth and seventh tergites and the posterior third of each of the remaining ones black or dark brown; hairs pale. Hypopygium (fig. 133) yellow, resembling that of *M. lucorum* Winn; superior forceps are broad, and with rounded margins, setose; the intermediate appendages are long and very slender, doubly sinuate, somewhat flattened, tapering at the apex and produced beyond the forceps; the caudal margin of the ventral sclerite is straight, strongly ciliate and with a small rounded protuberance on each lateral angle. The legs are yellow and quite slender, tarsi slightly darker; fore metatarsus is ¾ as long as its tibia, the larger setæ of the hind tibiæ are shorter than the diameter of the member. Wings (fig. 102) hyaline, slightly yellow tinged; subcosta ends in the costa proximad of the distal end of the small cell; subcostal crossvein is placed nearly at the middle of this cell, which is about twice as long as wide; R_{4+5} ends nearly at the tip of the wing; the petiole of the media is longer than M_2; the cubitus forks almost directly under the R-M crossvein. Length of wing is 3.5 mm., which is 3.5 times as long as the fore metatarsus. Halteres yellow.

Female. Like the male but the wing is about 3.75 times as long as the fore metatarsus. New York; Rhode Island; Massachusetts (Johnson, col.); New Hampshire; Montreal. July and August.

Two females from Wisconsin collected by Professor Wheeler differ only in having the petiole of media and M_2 subequal.

8. *Mycomya tantilla* Loew.

1869. *tantilla,* Loew. Berl. Ent. Zeitschr. XIII. 140 (*Sciophila*).

Male. Length 3 mm. Head fuscous, palpi, proboscis, scape and basal joints of flagellum yellow, remainder of flagellum fuscous; basal flagellar joints about 1.5 times as long as wide; antennal hairs pale, setæ of head black. Thorax yellow, dorsum dark brown or with three subconfluent stripes in immature specimens; scutellum slightly infuscated; metanotum subfuscous, the four scutellar setæ and setæ of the thorax are black; dorsum with a few fine pale hairs. Abdomen yellow, tergites each more or less widely margined with black or dark brown, in well colored specimens the dark color is produced forward along the median line to almost the front margin leaving only more or less triangular yellow patches on the sides, in immature specimens the dark color is confined to the posterior third of the segment; hairs of abdomen dusky. Hypopygium (figs. 140, 143) yellow, resembling that of *M. brunnea* Dzied.; large; the inferior sclerite (shown folded down in fig. 140a, and in profile in fig. 143) is large, with 2 stout spines on each lateral margin projecting laterad; the intermediate appendages are slender, lanceolate, not produced much beyond the end of the inferior margin; the latter has four blunt lobes; in addition there are on the inner surface a pair of slender cylindrical processes and a pair of four-tined forks. The legs are yellow, quite slender; the fore metatarsus is ¾ as long as the tibia, the larger setæ of the hind tibia are longer than the diameter of this member. Wings (fig. 105) hyaline, slightly tinged with yellow; subcosta ends in the costa opposite the distad end of the cell R_1; the subcostal crossvein is about at the middle of this cell which is not twice as long on anterior margin as wide; R_{4+5} ends before the tip of the wing and very slightly before end of costa; petiole of the media is longer than M_2; the cubitus forks slightly distad of the R-M crossvein. Length of the wing is 3 mm., which is

2.75 times the length of the fore metatarsus. Halteres yellow.

Female. Like the male but the wing is proportionately larger. S. D. (Aldrich, col.); Wyoming and Wisconsin (Wheeler, Col.). September. Recorded also from Nebraska.

9. *Mycomya nigricauda* Adams.

1903. *nigricauda,* Adams, Kas. Science Quart. II. 23. (*Sciophila*).

Male. Length 4 mm. Yellow, subshining; head black, base of antennæ and mouth-parts yellow, sparse pile black; thorax yellow, in places slightly tinged with brown, viewed from before slightly grayish pollinose, pile black, halteres yellow; abdomen yellow, apices of segments, last one wholly black, hypopygium yellow, pile light brown; legs yellow, tarsi, except base, fuscous; wings hyaline, larger veins brown, subcostal crossvein near apex of subcostal vein and just before the middle of the cell R_1, first branch of media about as long as its prefurca, furcation of the cubitus takes place just beyond the small crossvein. Colorado City, Colo., July.

10. *Mycomya brevitittata* Coquillett.

1905. *brevivittata,* Coquillett, Journ. N. Y. Ent. Soc. XIII. 67. (*Sciophila*).

Male. Length 3.5 to 4 mm. Head reddish brown, vertex dusky; ocellar spot black, distinctly marked; face, palpi, proboscis, scape and basal joints of flagellum yellow, remainder of flagellum brown; antennæ rather short, compressed, first flagellal joint about twice, the others but little longer than wide. Thorax yellow, subopaque, lateral stripes brown or black, abbreviated anteriorly and not meeting posteriorly; a brown spot over the base of the wing, a geminate reddish brown median stripe not reaching the scutellum, dorsum and sides of metanotum and some spots on pleura, brown; the four scutellar setæ, and the marginal setæ of mesonotum black and conspicuous; the fine pale hairs more numerous than in related species. Abdomen yellow, the posterior third or half of each tergite blackish, subshining, sixth and seventh segments wholly black. Hypopygium (fig. 134) yellow, resembling that of *M. levis* Dzied., the two pairs of forceps and the intermediate appendages are all slender and not produced beyond the margin of the ventral sclerite; this sclerite is provided with a pair of lateral processes

each with about twelve stout setæ, and a median pair of slender palmate lobes each with six fingers which decrease in length outwardly. Legs yellow, slender; fore metatarsus about 0.8 as long as its tibia; setæ of hind tibia but little longer than the diameter of this member. Wings (fig. 104) hyaline, slightly smoky tinged, larger veins dusky yellow; subcosta ends in the costa before the middle of this cell; R_{4+5} ends slightly before the tip of the wing; petiole of the media about half as long as M_2; the cubitus forks proximad of the R-M crossvein. Length of wing is 3.5 mm., which is three times as long as the fore metatarsus. Halteres yellow. N. Y., Wis., Ill., May, July, August. The species was originally recorded from British Columbia.

11. *Mycomya marginalis* n. sp.

Male. Length 4.5 mm. Resembles *M. maxima* but differs in size and structure of the hypopygium. Head brown; face, palpi and base of antennæ yellow. Thorax yellow, the three wide stripes on mesonotum, lower margin of pleura, dark brown; scutellum yellowish brown; four scutellar setæ and setæ of mesonotum black; the finer hairs paler. Abdomen yellow; tergites each with a wide blackish longitudinal stripe, last segment wholly dark, hairs brownish. Hypopygium (fig. 135) somewhat resembles that of *M. maxima* but here the central "processus" is but feebly developed. Legs slender dusky yellow, fore metatarsus and tibia subequal, middle coxæ spurred; setæ of hind tibiæ about twice as long as the diameter of the member, hind coxæ brown on outer side. Wings like those of *M. maxima* but the subcosta ends in the costa a little proximad of the distal end of small cell. Length of wing is 4.5 mm., which is 2.5 times as long as the fore metatarsus. Halteres yellow. One specimen taken in July in the Selkirk Mts., B. C., by Mr. J. C. Bradley.

12 *Mycomya imitans* n. sp.

Male. Length 4 mm. Head and antennæ brownish; the basal joints of the latter, face, palpi, and in large part the occiput, yellow; ocellar spot black and sharply defined; intermediate antennal joints somewhat longer than wide, setæ of the head black. Thorax yellow, three dark brown dorsal stripes, the laterals converging but not meeting, nor quite reaching scutellum, abbreviated anteriorly; the geminate median stripe abbre-

viated posteriorly; metanotum yellowish brown; four scutellar bristles and setæ of the thorax black, finer hairs pale. Abdomen yellow, each tergite with dark brown posterior margin which is more or less produced forward in a dorsal line; sixth and seventh segments wholly dark; hairs pale. Hypopygium (figs. 132, 136) yellow, resembling that of *pulchella* Dzied., dorsally with a pair of doubly curved horn-like processes articulated at the base. Legs slender, yellow, fore metatarsus about 1⅛ times as long as the tibia; spur of middle coxæ sickle shaped, short, about ⅛ as long as the fore metatarsus; setæ of hind tibia not twice as long as the diameter of the member. Wings hyaline, yellow tinged; subcosta ends in the costa beyond the middle of the cell R_1, which is over twice as long as wide, the subcostal crossvein is near the middle of this cell; R_{4+5} ends at the tip of the wing; petiole of the media is about half as long as M_2; cubitus forks under or slightly proximad of the R-M crossvein. Length of wing is 4 mm., which is twice the length of the fore metatarsus. Halteres yellow.

Female. Like the male but the subcostal crossvein is distad of the middle of the cell R_1 and the coxal spurs are wanting. In immature specimens the brown markings of head, thorax and abdomen are less extended. Ithaca, N. Y.; Mass. and Wis. (Wheeler, col.); Selkirk Mts., B. C. (Bradley, col.); Kingston, R. I. (Barlow, col.). July and August

13. *Mycomya biseriata* Loew.

1869. *biseriata,* Loew, Berl. Ent. Zeitschr. XIII. 140. (*Sciophila*).

Male. Length 5.7 mm. Yellowish; vertex dusky. Thorax yellowish; dorsum with black pile; pleura with subfuscous spots. Abdomen with black pile; each segment excepting the first with a triangular fuscous black spot on each side which extends from the anterior nearly to the posterior margin. Legs pale yellow, tarsi more dusky. Wings uniformly tinged with cinereous yellow, veins dusky yellow; subcostal vein ends in the costa (in the left wing its apex is subobsolete in the type specimen); cell R_1 is large, the subcostal crossvein is placed at the middle of this cell; petiole of the media is shorter than the cell M_1 but nearly twice as long as cell R_1, cubitus forks under the base of the R-M crossvein. Recorded from the Red River, Canada.

An examination of the type shows that the posterior segments have 3 spots each, the middle spot becoming obsolete on the anterior segments.

Female. Length 5.5 mm. Head and face reddish yellow; scape and basal flagellar joints yellow, remaining joints more or less fuscous; basal flagellar joints over twice as long as wide; ocellar spot and setæ of the head black. Thorax yellow, 3 pale reddish brown dorsal stripes, the middle one divided; metanotum and lower part of pleura with brownish tinge. Setæ including the 4 of the scutellum, black, finer hairs pale. Abdomen yellow, each tergite with a large, black triangular spot on each side and an elongate median spot extending from the anterior nearly to the posterior margin thus forming a nearly continuous longitudinal stripe. Legs yellow, middle and hind coxæ with a large spot near the tip on outer side; tarsi infuscated; fore metatarsus about 0.85 as long as its tibia, setæ of the hind tibia less than twice as long as the diameter of the member. Wings hyaline, slightly cinereous, heavy veins yellowish brown; subcosta ends in the costa before the distal end of the cell R_1 which is about twice as long as wide; the subcostal crossvein is placed near the middle of this cell; R_{4+5} ends at the tip of the wing; the petiole of the media is about $\frac{5}{8}$ as long as M_2; the cubitus forks under or very slightly distad of the R-M crossvein; the wing is 5 mm. long, which is 3.3 times as long as the fore metatarsus. Halteres yellow. Two specimens from the Selkirk Mts., B. C., collected by Mr. J. C. Bradley in July.

14. *Mycomya maxima* n. sp.

Male. Length 6.5 mm. Head brown, occiput paler, face, palpi, scape, and base of first flagellar joint yellow; flagellum dark brown, intermediate joints about twice as long as wide; the two ocelli prominent; setæ black. Thorax yellow, three stripes on mesonotum dark brown, the middle one produced cephalad, the laterals abbreviated anteriorly but all three coalescent posteriorly; metanotum and two small spots over base of wing also brown; scutellum paler brown; setæ black, intermingled with very fine pale hairs; four black scutellar setæ. Abdomen yellow, each tergite with a dark brown or blackish spot extending from the anterior margin nearly to the posterior margin, widest at the middle; dorsum of the sixth and seventh

segments wholly black; hairs black. Hypopygium (fig. 137) dusky yellow, resembling that of *M. bicolor* Dzied, forceps slender, acuminate, the central "processus" truncate, with lateral setæ near the tip and projecting far beyond the superior forceps. Legs slender, dusky yellow, fore metatarsus 1.1 times as long as its tibia; each middle coxæ with a cephalad projecting sickle-shaped spur which is about 1-3 as long as the fore metatarsus; setæ of hind tibiæ little longer than the diameter of the member. Hind coxæ outwardly for the most part brown. Wings (fig. 106) hyaline, slightly cinereous tinged; subcosta ends in the costa opposite the distal end of the small cell; subcostal crossvein is before the middle of this cell, which is about twice as long as wide; R_{4+5} ends beyond the tip of the wing; petiole of the media is ¾ as long as M_2; cubitus forks proximad of the R-M crossvein. The wing is 6.5 mm. long, which is 2.1 times as long as the fore metatarsus. Halteres yellow. One specimen from Maine taken by Mr. Owen Bryant in August.

Female. A specimen taken at the same time and place differs as follows: lower margin of pleura is dark; the yellow of the abdominal tergites is confined to a posterior fascia, the fore metatarsus and tibia are subequal; coxal spurs wanting; subcosta interrupted at the tip; subcostal crossvein slightly distad of the middle of cell R_1; cubitus forks only slightly proximad of the R-M crossvein. Wing is three times as long as the fore metatarsus.

15. *Mycomya sigma* n. sp.

Male. Length 4 mm. Head, face, and antennæ brownish, the basal joints of the last and the palpi yellow; intermediate antennal joints but little longer than wide. Thorax yellow, the three dorsal stripes dark reddish brown, the middle one broad on anterior margin, tapering and not reaching the scutellum; the laterals abbreviately anteriorly and broadened posteriorly; metanotum and lower margins of pleura also brown; the two scutellar bristles and the setæ of mesonotum brown. Abdomen brown, posterior and lateral margin a little more yellowish, margins not sharply defined; hairs pale. Hypopygium (fig. 138) yellow; forceps short and slender, intermediate appendages lanceolate and acute and the "processus" consisting of a pair of slender, slightly clavate median lobes. Legs long and slender,

yellow; fore metatarsus 1 1-16 times the tibia in length, setæ of hind tibia but little longer than the diameter of the member. Wings hyaline, with a yellowish tinge; veins brownish yellow, subcosta ends in the costa about opposite the middle of the cell R_1 which is rather large, about 2.5 times as long as wide; the subcostal crossvein is proximad of the middle of this cell; the basal section of the radial sector and the R-M crossvein are subequal; R_{4+5} ends at the tip of the wing; petiole of the media is about 2-3 as long as M_2; cubitus forks distad of the R-M crossvein; the wing is 4 mm. in length, which is 2 1-6 times as long as the fore metatarsus. Halteres yellow. A single specimen taken in May by Mr. Wm. Beutenmuller in the Black Mts., N. C.

16. *Mycomya appendiculata* Loew.

1869. *appendiculata,* Loew. Berl. Ent. Zeitschr. XIII. 139. (*Sciophila*).

Male. Length 3.2 mm. Head and palpi yellowish, vertex dusky; antennæ fuscous black, the scape and first joint of flagellum yellow. Thorax pale yellowish, mesonotum somewhat darker; pile black. Abdomen fuscous black, the posterior margin of each tergite, yellowish; the penultimate segment wholly black or with subfuscous margin. Hypopygium small, yellow, with slender lateral appendages, black. Coxæ and legs pale yellow, tarsi fuscous black. Wings hyaline, cinereous tinged apically and posteriorly; cell R_{2+3} more deeply tinged; veins fuscous; subcostal vein, which is thin and pale basally, ends in the costa; cell R_1 small, the subcostal crossvein is placed proximad of the middle of this cell; petiole of the media over thrice as long as the cell R_1, but scarcely equaling the length of the cell itself; cubitus forks distad of the R-M crossvein. Halteres yellow. The species has been recorded from New York.

To the above may be added that the fore metatarsus is shorter than the tibia and the middle coxæ are provided with spurs.

17. *Mycomya hirticollis* Say.

1824. *hirticollis,* Say, Long's Exp. St. Peter's River. Appl. 362. (*Sciophila*).

Length 3.5 mm. Antennæ fuscous, the four basal joints yellow; head black, face, mouth and palpi pale yellowish. Mesonotum with traces of three stripes; pleura yellow with a brown

spot over the hind coxæ. Each tergite brown with both anterior and posterior margins yellow. Wing slightly cinereous tinged. Halteres pale yellowish. Legs yellow, tarsi dusky. Reported by Say from the Northwest Territory.

18. *Mycomya meridionalis* n. n.

1896. *diluta,* Williston, (preoc.) Trans. Ent. Soc. London. 263. (*Sciophila*).

Male. Length 3 mm. Reddish yellow; abdomen brown. Antennæ about as long as the head and thorax together, somewhat compressed; light brown, the basal joints yellow. Front and face brown or brownish-yellow, palpi brown. Thorax, coxæ and femora reddish or luteous yellow; mesonotum brownish-yellow, with black hairs and bristles. Abdomen brown or yellowish-brown, with black hairs. Tibiæ brown; tarsi blackish; front metatarsi a trifle shorter than their tibiæ; hind tarsi scarcely longer than the tibiæ. Wings tinged with brownish; the costal vein terminates at the tip of R_{4+5}; cell R_1 very short; furcation of the cubitus very nearly opposite the origin of the radial sector. St. Vincent Isl.

19. *Mycomya flavohirta* Coquillett.

1901. *flavohirta,* Coquillett. Proc. U. S. Nat. Mus. XXIII. 596. (*Sciophila*).

Male. Length 5 mm. Head black, the face and mouth parts yellow, first two joints of antennæ yellow, the remainder black, compressed, the third joint only slightly longer than broad; thorax and scutellum yellow, polished, the bristles and numerous, rather long hairs also yellow; abdomen polished, yellow, the bases of segments 2 to 5, the whole of the sixth, and apex of abdomen, black; legs yellow, the tarsi brownish; halteres yellow; wings hyaline, cell R_1 about twice as long as broad, cubitus forking far before base of the radial sector; petiole of media 2-7 as long as M_2; front tibiæ slightly longer than their tarsi; no coxal spur. N. H.

20. *Mycomya mendax* n. sp.

Male. Length 6 mm. Head black, face, palpi, and base of antennæ yellow, flagellum fuscous, intermediate joints over half again as long as wide gradually decreasing in length toward the apex. Thorax yellow, dorsum with 3 subconfluent black stripes, of which the laterals are anteriorly abbreviated; metanotum and

lower margin of pleura brownish; setæ black, fine hairs pale; 4 scutellar setæ black. Abdomen yellow, tergites black, excepting the wide posterior margins; hairs pale. Hypopygium (fig. 141) yellow with a black margin, resembling that of *M. ornata* Meig., superior forceps (fig. 142s) folded down in the figure, hidden by the large lobular intermediate appendages; the ventral sclerite with short lateral setose lobes (inferior forceps?) and having two strong mesad projecting spines; mesad of these is a pair of pectinate processes each with five or six teeth. Legs yellow, fore metatarsus about a twelfth shorter than the tibiæ; setæ of hind tibiæ about as long as the diameter of the member. Wings hyaline, yellowish tinged, larger veins yellowish brown; subcosta ends in the costa before the distal end of the cell R, which is twice as long as wide; subcostal crossvein near the middle of this cell; R_{4+5} ends at the apex of the wing; petiole of media is ¾ as long as M_2; cubitus forks under the R-M crossvein; anal vein strong; wing 5.5 mm. long, which is 2.5 times as long as the fore metatarsus. Halteres yellow.

Female. A female taken in cop. with the above differs in being paler (perhaps immature), having only traces of thoracic stripes; abdominal markings pale brown, confined to the basal half of the segments; wing twice as long as the fore metatarsus. One pair taken by Professor Aldrich at Juliaetta, Id. Also one specimen from Muir Woods, Marin Co., California, and another from Selkirk Mts., B. C., taken by Mr. J. C. Bradley.

Var. a. A female specimen from Moscow, Id., collected in June by Professor Aldrich and another collected in Muir Woods, California, by Mr. J. C. Bradley, differ in being rather darker, in having the cubitus fork distad of the R-M crossvein and the subcostal crossvein placed near the basal fourth of the cell R_1.

Var. b. A female specimen taken in the Sierra Morena Mts., California, by Mr. J. C. Bradley in April differs in having the fore metatarsus .8 as long as the tibia, the fork of the cubitus proximad of the R-M crossvein and the subcostal crossvein distad of the middle of the cell R_1. It is barely possible that this is the female of *M. calcarata* Coq.

21. *Mycomya nugatoria* n. sp.

nugatoria Wheeler, MS. (*Sciophila*).

Female. Length 3 mm. Face and 2 or 3 basal joints of the robust antennæ pale yellow; palpi and apical joints of antennæ

fuscous, the latter covered with white pubescence. Head back of the insertion of the antennæ opaque black. Thorax very convex; dorsum with scattered long black hairs, the center reddish from the confluence of obsolescent stripes. Scutellum short and broad, bearing 4 bristles. Abdomen dull pale yellow, clothed with black hairs; posterior margins of segments infuscated. Legs pale yellow; median coxa with a large fuscous spot at the apex; tibiæ apeparing darker than the femur because covered with denser black hairs. Tarsi infuscated towards their tips. Fore metatarsus 0.8 as long as the tibia; setæ of hind tibia no longer than the diameter of this member. Wing grayish hyaline, with yellowish veins; subcosta ends in the costa about opposite the distal end of the cell R_1, which is nearly twice as long as wide; subcostal crossvein is near the base of this cell; R_{4+5} ends before the tip of the wing; the petiole of the media is as long as M_2; the cubitus forks distad of the R-M crossvein; the wing is 3 mm. long, which is twice as long as the fore metatarsus. Milwaukee Co., Wis. (Prof. Wheeler, col.).

A female specimen from the Black Mts., N. C., taken in May by Mr. Wm. Beutenmuller differs in having dark thoracic stripes and tergites with darker posterior margins; the cell R_1 also is slightly shorter and more distinctly trapezoidal.

22. *Mycomya onusta* Loew.

1869. *onusta,* Loew, Berl. Ent. Zeitschr. XIII. 138. (*Sciophila*).

Female. Length 3.7 mm Yellowish, pilose, the setæ blackish, the hairs pale. Head yellowish, vertex dusky; scape pale yellow, flagellum fuscous black, the first joint of the latter sometimes pale yellow; palpi subfuscous. Mesonotum with two wide stripes, abbreviated anteriorly, and between them anteriorly may be seen the beginning of a subfuscous median stripe; disk of scutellum subfuscous; pleura with subfuscous spots. Apical half of each tergite fuscous black. Coxæ and legs pale yellow; tarsi fuscous. Wings uniformly cinereous, veins fuscous; subcostal vein which is paler and more slender than the other veins is thickened and darkened at the extremity and ends in the costa; cell R_1 is large, the subcostal crossvein is placed at the middle of this cell; petiole of the media is nearly 1.5 times as long as the cell R_1, and less than half as long as M_2; cubitus forks proximad of the R-M crossvein. Length of wing 3.8 mm. Recorded from the District of Columbia.

23. *Mycomya recurva* n. sp.

Female. Length 5 mm. Pale yellow; face, cheeks, palpi and 5 or 6 basal joints of antennæ rufous yellow, apical joints of antennæ fuscous; front and occiput dull brownish black, dusted with white. Thorax pale yellow, subopaque, appearing as if dusted with white; dorsum with a few sparse, rather long black hairs and 4 distinct reddish brown stripes. The inner pair is approximated, very narrow, beginning on the anterior edge of the dorsum, tapering posteriorly and terminating a short distance in front of the insertion of the scutellum; lateral bands broader, beginning a short distance from the anterior edge of the dorsum and terminating acutely in the posterior edge. Scutellum with pale fuscous disk, bearing 2 moderately long setæ. Pleura somewhat fuscous posteriorly. Metanotum sordid with fuscous. Ground color of abdomen inclining to sulphur yellow; basal 2-3 of the tergum of each segment pale fuscous; a black band runs down the median dorsal line interrupted at the pale edges of the segment. Venter and genitalia uniform pale yellow. Legs pale yellow, lacking the whitish dust of the thorax; posterior coxæ each with an elongate fuscous spot; all the femora at their point of insertion very narrowly but distinctly edged with black; hind tibiæ with a row of about 7 almost equidistant spines on their outer faces. Fore metatarsus less than 1-12 longer than the tibia; setæ of the hind tibia nearly twice as long as the diameter of this member. Wing grayish hyaline, lutescent along the costal margin; subcosta ends in the costa before the distal end of cell R_1 which is about twice as long as wide; subcostal crossvein is at the middle of this cell; R_{4+5} ends at the tip of the wing; the petiole of the media is 0.7 as long as M_2; the cubitus forks slightly proximad of the R-M crossvein; the wing is 5 mm. long, which is 2.3 times as long as the fore metatarsus. Wisconsin (W. M. Wheeler, col.).

Another female specimen from this locality differs in having 3 more or less confluent spots on each tergite, forming a wide basal fascia with tridentate margin.

Var. *chloratica* n. var. Wheeler MS. Subcostal crossvein is situated proximad of the middle of the cell R_1; subcosta ends in the costa beyond the middle of the cell R_1 which is not twice as long as wide. Milwaukee Co., Wisconsin (W. M. Wheeler. col.).

24. *Mycomya incompta* n. sp.

Female. Length 4.5 to 5 mm. Head black, lower part of face, palpi, scape, and under side of first flagellar joint, yellow; intermediate flagellar joints about twice as long as wide with whitish pubescence; setæ of the head black. Thorax yellow, the 3 subconfluent dorsal stripes, scutellum, metanotum, and lower margin of pleura brown; setæ including those of the scutellum black. Abdomen yellow; the tergites brown with wide yellow posterior margins; hairs pale. Legs yellow, tibiæ and tarsi appear darker; the fore metatarsus about ¼ longer than the tibia; setæ of hind tibia about twice as long as the diameter of the member. Wings hyaline, cinereous tinged; subcosta ends in the costa nearly opposite the distal end of cell R_1 which is about twice as long as wide; the subcostal crossvein is placed very slightly distad of the middle of this cell; R_{4+5} ends beyond the tip of the wing; the petiole of the media is ¾ as long as M_2; the cubitus forks proximad of the R-M crossvein; the wing is 4 mm. in length, which is 2 1-7 times as long as the fore metatarsus. Halteres yellow.

Two specimens taken by Mr. J. C. Bradley in the Selkirk Mts. in August; one from Ithaca, N. Y.; and one from Capen, Maine. (Johnson, col.).

25. *Mycomya angulata* Adams.

1903. *angulata,* Adams. Kas. Univ. Science Bul. II. 22. (*Sciophila*).

Female. Length 6 mm. Yellow, subshining; head black, anterior part of front, base of antennæ, face and mouth-parts yellow; thorax yellow, mesonotum with 3 subcoalesced fuscous fasciæ, the middle one abbreviated behind, the lateral ones in front, pile, rather long and yellow, large spot on the pleura above middle coxæ brown; abdomen yellow, base of segments brown, pile black; legs light yellow, anterior tibiæ shorter than their tarsi; tips of tarsi fuscous; wings grayish hyaline, cell R_1 twice as long as broad, R_{2+3} angulate, its apex turned towards base of wing, subcostal crossvein slightly beyond middle of cell R_1. Manitou Park, Colo., August. It is near *S. flavohirta* Coq., but differs in the markings of the thorax, length of anterior tibiæ, and the angulated R_{2+3}.

ADDENDA.

Monoclona furcata n. sp.

Resembles *elegantula* in coloring but differs in the form of its hypopygium, the slightly greater length of the fore metatarsus relative to its tibia, and in the relative positions of apices of Sc, R_1 and R_{4+5}.

Male. Length 4 mm. Head black; palpi, face, scape of antenna and the 2 basal joints of flagellum yellow, the remaining flagellar joints fuscous. Thorax yellow, the mesonotum with 3 blackish stripes, metanotum, some spots on the pleura and the sternum more or less infuscated; hairs pale. Each abdominal tergite largely brownish, yellowish at the incisures, venter yellow; hypopygium dark brown, each limb of the forceps with 2 strong hooks united to a broad base to which is attached a very slender fishhook-like process projecting mesad. Legs yellow, tarsi somewhat darker; fore metatarsus over 0.95, the second fore tarsal joint over half as long as the fore tibia; tarsal claws each with a strong tooth at the base. Wings yellowish hyaline, veins dusky yellow; the small cell shorter than wide; the distance from the apex of Sc_1 to R_1 is over 2.5 times the distance from R_1 to R_{4+5}; in *elegantula* these distances are to each other as 2 to 1. Stem of the halteres yellow, the elongate knob black.

A single specimen taken at Orono, Maine, May 26, 1910.

Mycomya maxima.

Female. A specimen of this species taken in Orono, Maine, June, 1910, resembles the male described on page 179 in wing venation, the subcosta ending in the costa. The dorsal mark on each tergite is rather narrower than in the previously described specimens. I am now inclined to think that the female described before is abnormal in venation. In the table given on page 169 this species will fall into the couplet with *mendax,* from which it may be distinguished by its relatively longer fore metatarsus.

LEG MEASUREMENTS.

These tables give the relative measurements of the joints of the legs, the fore tibia (T) being taken as unity.

Name.	Hind Leg.							Middle Leg.							Fore Leg.						
	5	4	3	2	1	T	F	5	4	3	2	1	T	F	5	4	3	2	1	T	F
Monoclona elegantula, male	19	21	24	32	90	180	152	18	21	29	39	94	116	130	16	26	35	48	87	100	94
Eudicrana obumbrata, male	20	26	41	51	100	177	115	18	28	44	54	113	136	92	25	36	56	67	136	100	80
Tetragoneura nitida, male	27	32	38	47	114	237	174	–	–	30	33	93	134	150	25	27	30	33	67	100	110
Sciophila quadratula var. a. female	12	17	27	44	97	154	116	12	17	27	45	89	117	86	16	23	36	54	95	100	70
Sciophila glabana, male	12	19	27	44	91	152	108	–	–	–	–	–	112	77	15	27	37	60	98	100	72
Sciophila nugax, male	16	26	29	32	97	184	139	13	16	26	42	94	139	120	10	19	35	50	100	100	102
Sciophila habilis, male	14	22	28	39	89	186	148	14	19	28	42	86	128	120	17	25	44	50	95	100	100
Sciophila hebes, male	18	23	26	41	94	188	142	18	23	28	46	91	130	124	18	23	35	53	97	100	102
Sciophila impar, male	14	17	25	43	88	170	128	15	18	28	43	82	124	102	17	20	31	49	85	100	92
Sciophila severa, male	15	18	24	42	81	159	135	15	18	21	42	81	126	114	15	19	33	54	90	100	90
Sciophila pallipes, male	17	19	26	42	112	164	130	14	19	28	44	86	124	104	14	23	35	44	93	100	86
Paratinia recurva, male	12	15	16	26	80	146	93	9	14	18	29	77	116	70	12	16	22	32	91	100	69
Polylepta obediens, male	14	17	31	48	84	152	100	12	19	33	48	81	119	78	–	–	–	–	–	–	–
Polylepta obediens, female	14	17	28	50	84	157	110	12	19	33	48	83	131	83	17	27	43	64	114	100	71
Polylepta nigellus, male	–	–	–	–	–	–	–	17	22	39	50	92	111	104	14	22	31	42	70	100	92
Dziedzickia pullata, male	13	17	21	30	93	171	129	12	18	21	33	93	121	87	15	24	27	42	75	100	75
Diomonus pulcher, male	22	27	33	41	106	195	136	–	22	36	50	114	136	100	–	33	42	64	140	100	86
Diomonus pulcher, female	–	–	–	–	111	180	150	18	21	36	54	114	135	108	–	–	42	60	123	100	111
Diomonus bifasciata, male	–	–	–	–	–	–	–	–	–	–	–	–	–	–	23	27	42	63	148	100	84
Diomonus magnificus, male	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	134	100	87
Diomonus magnificus, female	21	25	43	50	129	204	161	21	28	39	45	125	139	100	21	39	46	61	140	100	90
Neoempheria macularis, male	15	20	27	40	91	169	106	15	23	30	40	95	131	106	15	27	37	50	95	100	95
Neoempheria macularis, female	14	19	28	46	104	167	119	17	20	28	42	106	123	72	–	–	36	52	100	100	77
Neoempheria nepticula	–	–	–	–	–	–	–	–	–	–	–	–	–	–	25	37	51	67	100	100	80
Neoempheria indulgens, male	–	–	–	–	–	–	–	–	–	–	–	–	–	–	19	25	35	57	85	100	109
Neoempheria indulgens, female	–	–	–	–	–	140	118	23	26	32	40	92	138	124	20	28	37	60	85	100	90
Neoempheria impatiens, female	–	–	–	–	–	225	174	23	31	43	53	116	168	147	25	37	53	69	98	100	98
Neoempheria illustris, male	17	21	25	40	92	170	118	17	18	29	39	95	135	104	20	24	37	49	92	100	68
Neoempheria illustris, female	–	–	–	–	–	–	–	–	–	–	–	–	–	–	20	26	42	55	97	100	71

Name.	Hind Leg.							Middle Leg.							Fore Leg.						
	5	4	3	2	1	T	F	5	4	3	2	1	T	F	5	4	3	2	1	T	F
Neoempheria balioptera, male	18	21	32	45	96	168	136	18	21	33	38	87	142	118	20	23	34	44	87	100	87
Mycomya sequax, male	13	16	25	45	108	169	122	15	19	29	51	102	122	86	16	25	45	76	133	100	76
Mycomya sequax, female	13	17	24	43	102	161	118	15	19	28	50	102	133	82	17	24	41	69	116	100	74
Mycomya imitans, male	12	15	19	38	91	150	113	13	16	25	44	85	121	83	21	26	38	57	112	100	72
Mycomya imitans, female	11	14	19	36	85	141	104	13	16	27	44	88	117	78	16	24	35	56	110	100	72
Mycomya marginalis, male	14	16	27	41	113	168	106	15	18	29	48	97	126	89	–	–	–	60	100	100	81
Mycomya littoralis, male	15	17	24	39	87	152	122	15	17	30	48	83	130	100	17	26	41	52	78	100	78
Mycomya littoralis, female	15	17	22	35	81	148	112	17	20	28	44	74	118	92	18	28	41	52	74	100	81
Mycomya maxima, male	13	17	25	47	118	169	102	15	19	27	50	101	140	94	–	25	44	69	110	100	68
Mycomya maxima, female	17	20	33	50	125	186	116	–	23	33	50	93	130	106	20	28	42	62	100	100	–
Mycomya sigma, male	–	–	–	–	–	–	–	15	19	29	49	98	124	85	17	29	42	59	102	100	75
Mycomya tantilla, male	10	12	20	28	84	140	100	12	14	22	46	78	118	80	18	20	28	44	74	100	70
Mycomya obliqua, male	15	18	26	41	92	159	126	18	20	33	44	82	126	100	23	28	43	56	77	100	85
Mycomya obliqua, female	15	17	27	44	102	171	126	18	22	33	46	90	132	110	24	32	44	54	79	100	93
Mycomya brevivittata, male	12	14	19	28	85	159	131	14	17	24	36	78	119	119	15	18	29	41	79	100	86
Mycomya mendax, male	15	18	25	42	100	163	111	15	22	29	51	92	113	88	20	32	43	62	92	100	77
Mycomya mendax, female	13	16	23	39	91	150	100	14	18	29	44	87	116	85	17	27	42	56	93	100	80
Mycomya mendax, female, var. a	12	17	28	46	98	161	116	12	18	31	46	89	123	88	15	28	42	58	92	100	71
Mycomya mendax, female, var. b	13	16	25	38	93	160	112	14	18	24	41	90	122	96	18	21	32	48	80	100	84
Mycomya incompta, female	14	17	27	41	114	172	114	14	19	31	49	106	138	97	15	28	45	70	126	100	93
Mycomya biseriata, female	18	23	33	49	106	167	130	19	25	35	47	86	123	105	24	32	40	54	84	100	97
Mycomya nugatoria, female	14	16	22	33	81	162	–	14	16	23	41	81	127	–	22	27	33	51	81	100	90
Mycomya recurva, female	15	22	29	47	106	168	118	18	22	33	55	102	127	96	22	31	47	73	104	100	73
Mycomya recurva, female, var. chloratica	14	18	28	48	108	171	119	–	–	–	–	–	125	85	21	30	46	69	104	100	75

Plate.

Fig. 83. Eudicrana obumbrata.
" 84. Monoclona elegantula.
" 85. Tetragoneura nitida.
" 86. Sciophila (Lasiosoma).
" 87. Paratinia recurva.
" 88. Polylepta obediens.
" 89. " nigellus.
" 90. " leptogaster (after Winnertz).
" 91. Empalia (after Winnertz).
" 92. Dziedzickia pullata.
" 93. Hadroneura (after Lundström).
" 94. Diomonus.

Plate.

Fig. 95. Neœmpheria nepticula.
" 96. " impatiens.
" 97. " balioptera.
" 98. " macularis.
" 99. " indulgens.
" 100. " illustris.
" 101. Mycomya littoralis.
" 102. " obliqua.
" 103. " sequax.
" 104. " brevivittata.
" 105. " tantilla.
" 106. " maxima.

Plate.

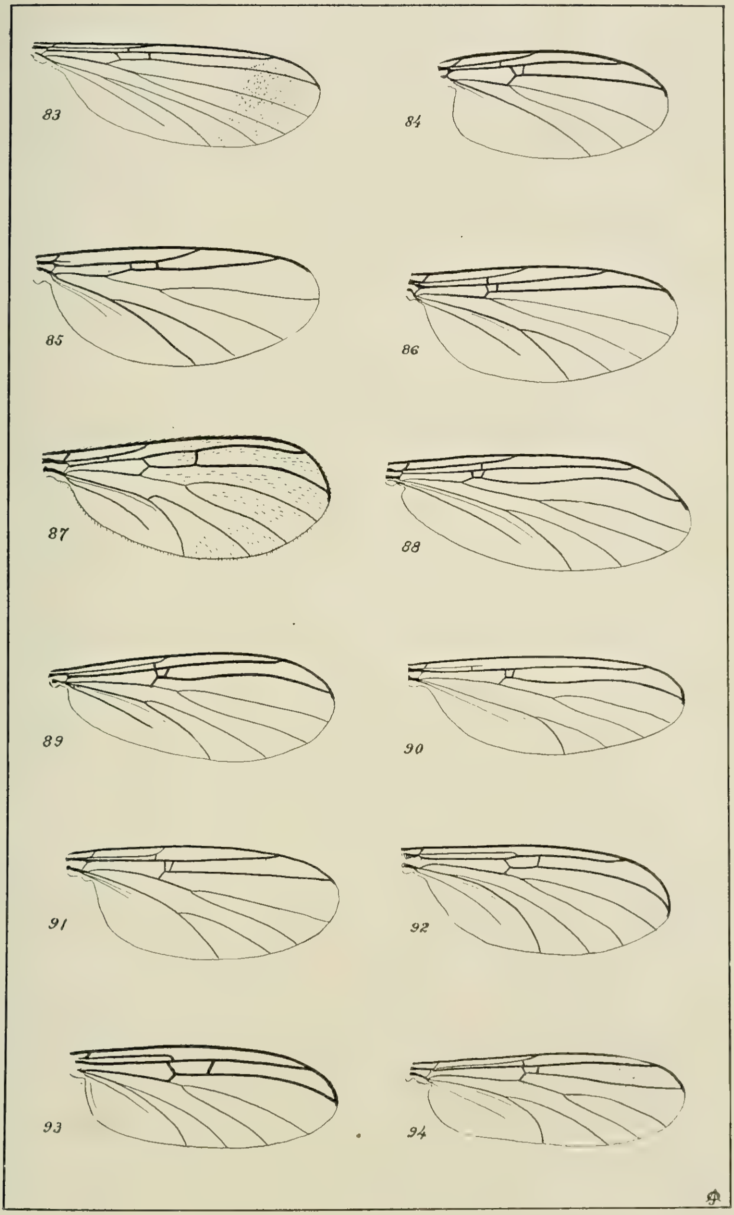
Hypopygia.

Fig. 107. Monoclona elegantula. One limb of forceps. x 200.
" 108. Tetragoneura nitida. Dorsal aspect. x 200.
" 109. Sciophila (Lasiosoma) habilis. Dorsal aspect. x 200.
" 110. " " glabana. Ventral aspect. x 100.
" 111. Eudicrana obumbrata. x 100.
" 112. Sciophila (Lasiosoma) severa. Dorsal aspect. x 200.
" 113. " " hebes. Dorsal aspect. x 200.
" 114. Diomonus magnificus. One limb of inferior forceps. x 100.
" 115. Sciophila (Lasiosoma) nugax. Dorsal aspect. x 200.
" 116. " " impar. Mesal aspect. x 200.

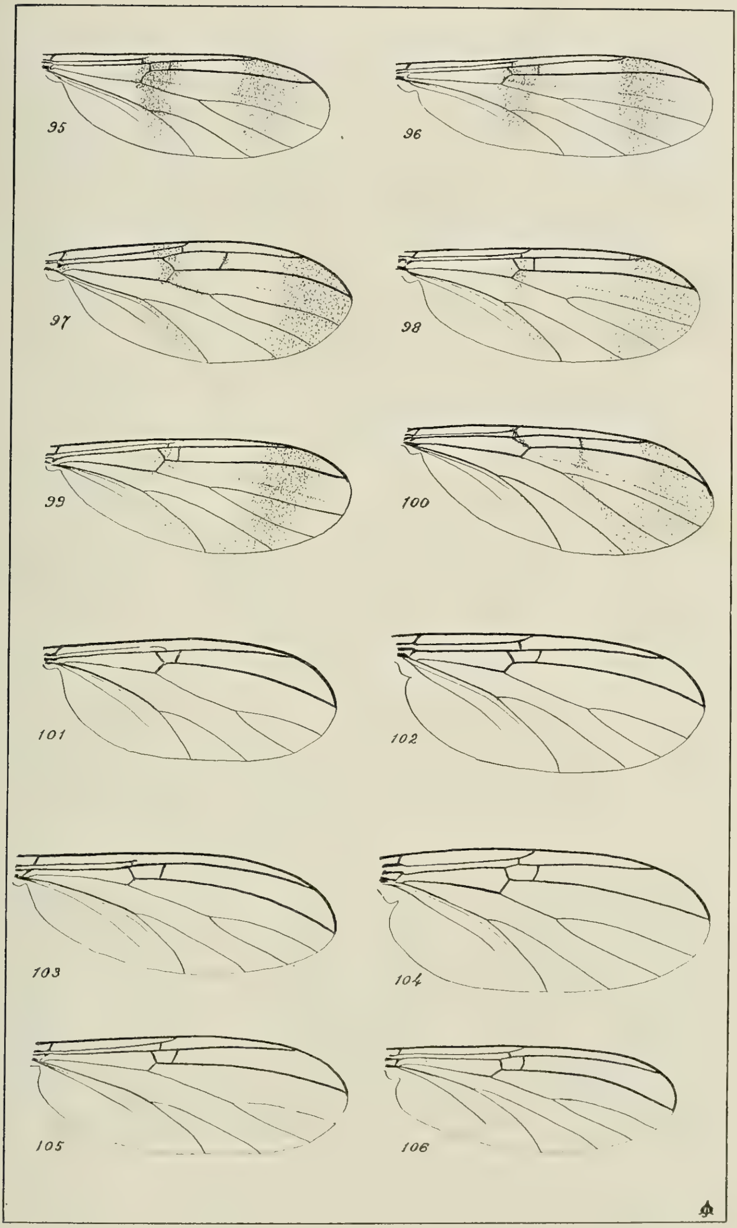
Fig. 117. Sciophila (Lasiosoma) novata. Ventral aspect. x 100.
" 118. Polylepta obediens. Ventral aspect. x 200.
" 119. Sciophila (Lasiosoma) novata. Dorsal aspect. x 100.
" 120. Dziedzickia pullata. Dorsal aspect. x 100.
" 121. Polylepta nigellus. Ventral aspect. x 100.
" 122. Sciophila (Lasiosoma) glabana. Ventral aspect of dorsal sclerite. x 200.
" 123. Diomonus bifasciatus. Ventral aspect. x 100.
" 124. Paratinia recurva. Dorsal aspect. x 200.
" 125. Diomonus pulcher. Ventral aspect. x 100.

Plate.

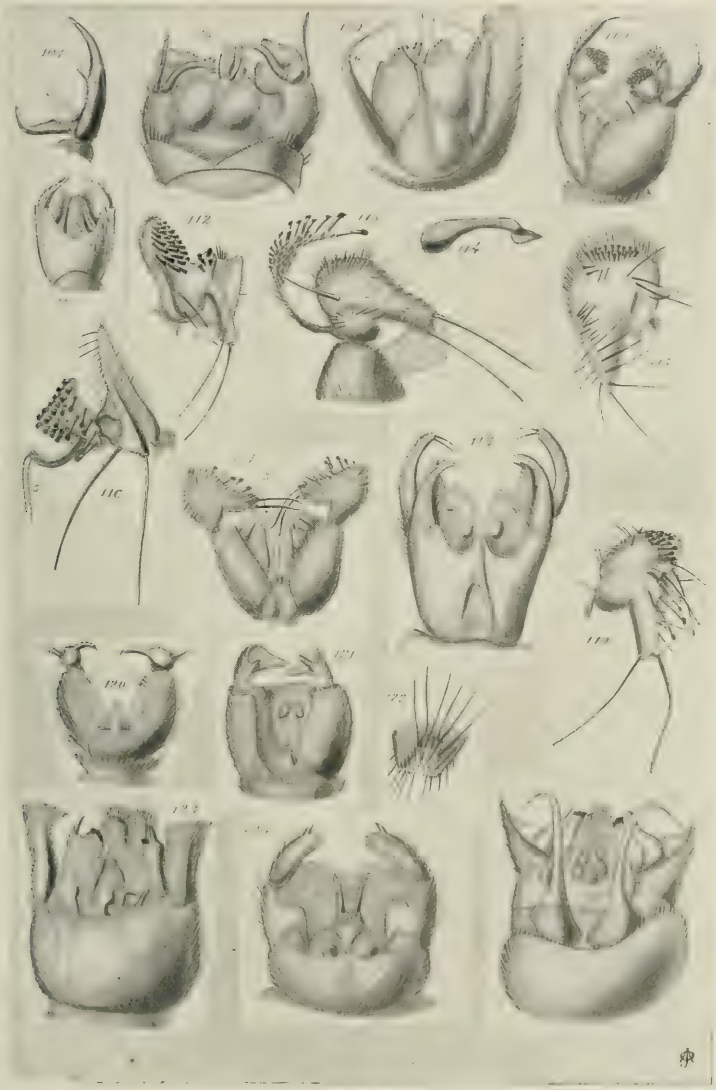
Fig. 126. Neœmpheria illustris. Dorsal aspect. x 85.
" 127. " " Lateral aspect, limb of inferior forceps. x 85.
" 128. " indulgens. Ventral aspect. x 85.
" 129. " balioptera. Oblique lateral aspect. x 35.
" 130. " macularis. Dorsal aspect. x 110.
" 131. " impatiens (ovipositor). Lateral aspect. x 65.
" 132. Mycomya imitans. Lateral aspect. x 65.
" 133. " obliqua. Dorsal aspect. x 65.
" 134. " brevivittata. Dorsal aspect. x 65.
" 135. " marginalis. Ventral aspect. x 65.
" 136. " imitans. Dorsal aspect. x 65.
" 137. " maxima. Dorsal aspect. x 65.
" 138. " sigma. Lateral aspect. x 35.
" 139. " biseriata (ovipositor). Lateral aspect. x 35
" 140. " tantilla. Open. x 65.
" 141. " mendax. Dorsal aspect. x 35.
" 142. " " Limb of superior forceps (s) and of intermediate appendage. (i) x 110.
" 143. " tantilla. Lateral aspect of ventral sclerite. x 65.
" 144. " littoralis, var. frequens. Dorsal aspect. x 35.
" 145. " " Superior forceps. x 110.
" 146. " sequax. Dorsal aspect. x 85.
" 147. " sp. Lateral aspect. x 65.



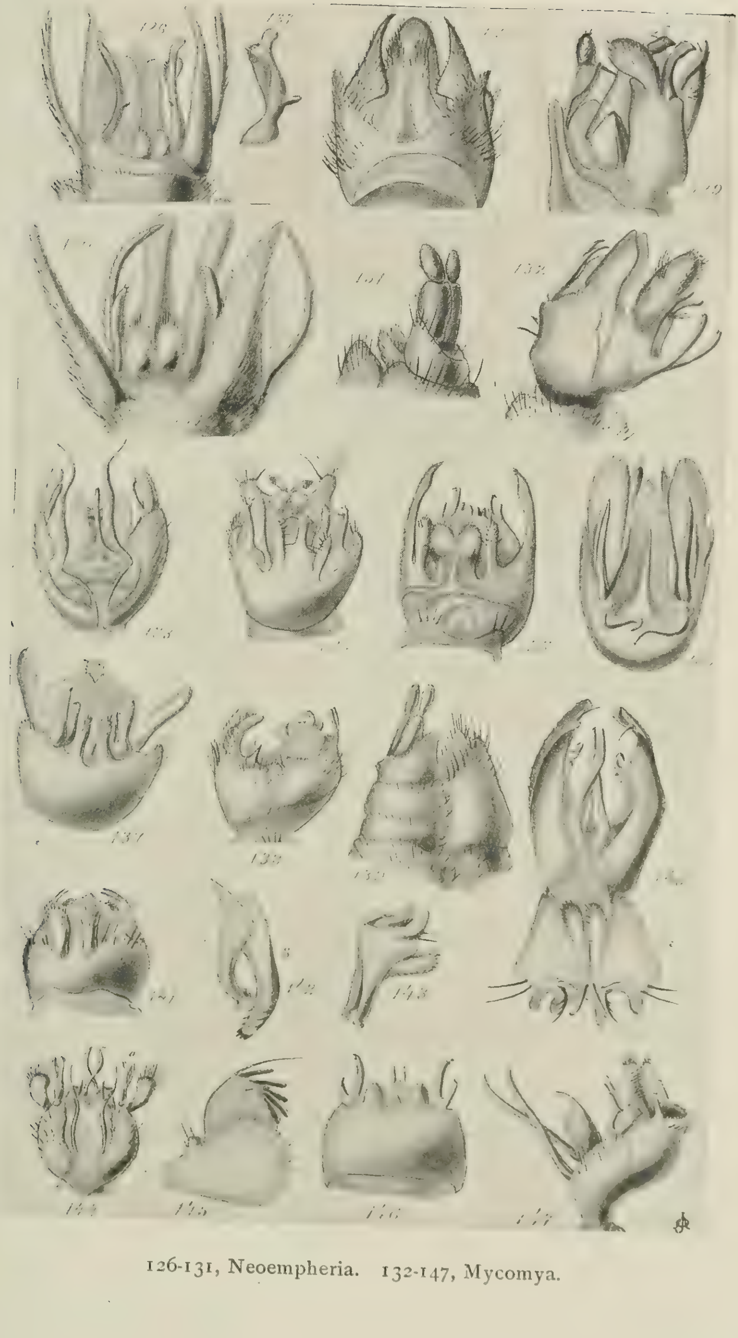
83, Eudicrana; 84, Monoclona; 85, Tetragoneura; 86, Sciophila (*Lasiosoma*); 87, Paratinia; 88-90, Polylepta; 91, Empalia; 92, Dziedzickia; 93, Hadroneura; 94, Diomonus.



95-100, Neoempheria. 101-106, Mycomya.



107, Monoclona; 108, Tetragoneura; 109, 110, 112, 113, 115, 116, 117, 119, 122, Sciophila *(Lasiosoma)*; 111, Eudicrana; 114, Diomonus; 118, 121, Polylepta; 120, Dziedzickia; 123, 125, Diomonus; 124, Paratinia.



126-131, Neoempheria. 132-147, Mycomya.

BULLETIN No. 181.

GALL APHIDS OF THE ELM.*

EDITH M. PATCH.

INTRODUCTION.

The study of this little group of elm aphids involves various problems, certain of which may be outlined here, as they add an interest to the species concerned.

Colopha ulmicola is considered by some the same as *Colopha compressa* of Europe. Even if this be the case, I have chosen to retain the American name for this species because it seems discreet to be entirely sure of the relations of this insect in one country before getting it involved with European problems.

So far as the literature is concerned the cockscomb gall in America has been so constantly associated with *Colopha ulmicola* that it was with considerable surprise that I found that the species issuing from the cockscomb gall in Maine in 1909 was not a *Colopha* but a *Tetraneura.* This cockscomb *Tetraneura* was, it seems, first taken by that most excellent observer Mr. Pergande years ago and in a correspondence with Mr. Monell received the name of *Tetraneura colophoidea* Monell mss. This species was described and figured under the name of *Tetraneura ulmi* (by error) by Mr. Sanborn,† but the name of *colophoidea* never escaped manuscript except in a paper "Upon the Aphis-feeding Species of Aphelinus" by Doctor Howard,‡ where it was merely mentioned.

The differences between *T. colophoidea* and *C. ulmicola* except for the venation are perhaps not such as would definitely

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*Papers from the Maine Agricultural Experiment Station: Entomology No. 43.

†Kansas Aphid, page 23.

‡Ent. News, October 1908, p. 365.

separate these species, but as the venation runs constant in certain large collections it seems expedient to consider them as distinct unless future study shall show them to be dimorphic forms of the same species.

There can be no doubt that *Tetraneura colophoidea* is the elm gall form of *graminis* (on grass). Similarly there seems no longer any reason to hold *Colopha eragrostidis* (on grass) distinct from *ulmicola* of the elm.

Tetraneura ulmisacculi is described as a new species. It may prove to be a European species. It accords fairly well with Buckton's* characterization of *Tetraneura ulmi* both as to gall and insect. It does not accord with Lichtenstein's characterization of *ulmi*† nor *alba*.† The gall would preclude it from *rubra*, and as the European literature is not entirely clear for the species of *Tetraneura* it seems expedient to consider *ulmisacculi* as distinct from European species unless it can be definitely shown to be the same.

Tetraneura ulmi has been several times recorded for America but, except for some introduced specimens‡ which died out after the first year, there is no reason for considering these records as authentic for that species.

Schizoneura americana is by some considered the same as the European *Schizoneura ulmi*. If not the same it is certainly very closely allied. The fate of the migrants of this species has never been clearly followed. I find no recognizable constant differences between *americana* of the elm leaf curl and *rileyi* of the elm trunk and branch, and consider them possibly to be the same species. Biological proof of this is lacking.

The gall of *Pemphigus ulmifusus* was described by Walsh 40 years ago but except for a few words and comment at that time the insect was never characterized at all until it was described and figured from a specimen with freak venation as *Schizoneura* sp.§ in 1904.

The present bulletin indicates the following unsolved or partly solved problems for the gall aphids of the elm.

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*British Aphides.

†Les Pucerons des Ormeaux.

‡Monell, Can. Ent. Vol. 14, p. 16.

§Sanborn, Kansas Aphid, p. 28 and Plate VI, fig. 41.

1. The fate of the migrants of *Schizoneura americana,* the relation of this species to *rileyi.*

2. The complete life cycle of *Tetraneura graminis.*

3. The complete life cycle of *Colopha ulmicola.*

4. The relation of *Colopha ulmicola* and *Tetraneura* (*colophoidea*) *graminis* whether distinct species or dimorphic forms of the same.

5. The fate of the migrants of *Pemphigus ulmifusus,* and alternate host.

6. The fate of the migrants of *Tetraneura ulmisacculi* and alternate host.

7. The relation of the American species to the corresponding European species.

It is with some hesitation that I present this group of aphids with so much still not ascertained concerning them. Yet the well-nigh hopeless mixups in the records of these species would need to be straightened if possible.

This initial step I have earnestly attempted. The previously existing records, in many instances entirely unrelated as they stand, are correlated in this present paper so that they are presented as a unit (of a scrapbook nature it is true) in order that certain previous errors need not be repeated. The original descriptions of all the species have been quoted verbatim, as these are for the most part no longer available and a reference to them is necessary. Some entirely new data, for the most part slight, I have been able to add to each of the old species considered, but the paper is very largely compiled as will be seen by the liberal quantity of quotation marks.

Even so much order in the existing chaotic records of these few species as is here given would have been impossible except for the generous aid which I have received. In this connection I wish especially to thank Mr. J. T. Monell, who has gone carefully over the *Colopha-Tetraneura* situation so familiar to him, and sent me profuse notes and extracts and lent me aphid mounts most valuable for study, and I wish also cordially to thank Professor Oestlund, Mr. F. A. Sirrine and Mr. J. J. Davis, who have given me specimens and other aid most serviceable in the present study.

COLOPHA ULMICOLA

Byrsocrypta ulmicola Fitch.
Thelaxes ulmicola Walsh.
Pemphigus ulmicola Packard.
Pemphigus ulmicola Smith.
Colopha ulmicola Monell.
Glyphina ulmicola Thomas.
Colopha compressa (Koch) Lichtenstein and Cholodkovsky et al.
Colopha eragrostidis Middleton.

In spite of the fact that this species is recorded by many and from many localities, very few original observations have been published since the Riley-Monell paper. From the character of most of the records of *Colopha ulmicola* it is quite impossible to tell whether they refer to *ulmicola* or *colophoidea*. Probably a verbatim quotation of the more significant accounts would be a convenience for the purposes of this bulletin,—that is to bring together what is known concerning the gall aphids of the elm for America.

Fitch's characterization (1858) is reproduced entire as follows:

"347. Elm Gall-louse, *Byrsocrypta Ulmicola,* new species (*Homoptera. Aphidae.*)

"In June, an excrescence or follicle like a cock's comb, arising abruptly from the upper surface of the leaf, usually about an inch long and a quarter of an inch high, compressed and its sides wrinkled perpendicularly and its summit irregularly gashed and toothed, of a paler green color than the leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plaits and occupied by one female and a number of her young, some of which are often strolling outside upon the under surface of the leaf, minute oval yellowish white lice 0.02 long, with blackish legs, the female more or less coated with white meal on her back, 0.07 long, oval and pale yellow with blacklish legs and antennae. Though I have not yet met with winged individuals, they in all probability pertain to the genus to which I have referred this species above. The galls may frequently be noticed on elm leaves. By the middle of summer they become tenantless, dry and hard and of a blackish brown color."

Walsh's (1862) description of the insect reads:

"*Thelaxes ulmicola* Fitch. New imago.—Black, more or less pruinose. Legs with the base of the femora and of the tibiae sometimes pale.

Wings hyaline; costa to the base of the stigma very pale fuscous, the stigma a little darker; veins fuscous, the 3rd discoidal hyaline half-way from its base to the fork; hind wings with the veins subhyaline. Length to tip of wings .05—.07 inch.

"Nine specimens. The antennae do not quite attain the origin of the first discoidal when the wings are expanded, and the stigma is twice as long as wide and hunched both anteriorly and posteriorly, its tips moderately acute. Occurs in elm-leaf galls, which are well described by Fitch (loc. cit.)."

Riley in the Riley-Monell paper gives the following discussion of *Colopha ulmicola* which is reproduced entire:

"COLOPHA* ULMICOLA (Fitch).

"(Forming cock's-comb-like galls (Fig. 129 a) on the upper surface of the leaves of *Ulmus americana,* the galls appearing with the opening of the leaves, and turning brown and black in late summer.)

"Another very common gall, which may be called the Cock's-comb Elm Gall (*ulmi-ulmicola*) is also found on the White Elm, and particularly as in the case of the previous gall, on young trees. It was well described by Fitch† as an excrescence or follicle like a cock's comb, arising abruptly on the upper side of the leaves, usually one inch long and ¼ of an inch high, compressed and its sides wrinkled perpendicularly and its summit irregularly gashed and toothed; of a paler green color than the

"*The bibliography of this species very well illustrates the confusion that too often surrounds the proper determination, not only of insects of this family, but of all orders. It is due to three causes, not easily removed: 1st, the miserably insufficient nature of the earlier descriptions and definitions; 2nd, the isolation of the earlier English entomologists from those of the continent, and the dual nomenclature that has arisen from independent work; 3rd, the want of a common ground for generic characterization. Walsh referred the species to *Thelaxes,* which has, however, 5-jointed antennae. *Vacuna,* Heyden, is synonymous with *Thelaxes,* though Walker would restrict the former to *alni,* Schrank, and the latter to *dryophila,* Schrank ("The Zoologist", London, February 1870, p. 2001), without pointing out generic differences, as the want of a fork in the cubital vein in Koch's figure is clearly an error of the artist. Mr. Monell founded the genus *Colopha* for *ulmicola* on the fact that the antennae of the winged female are 6-jointed. Such a difference can hardly have generic value when we find *ulmicola* occasionally with but 5 antennal joints, and (if Huxley is correct in his determination) *dryophila* sometimes with six (Trans. Linn. Soc. xxii, pp. 203, 234). But, taken in connection with the fact that *ulmicola* is a flocculent species, the true female producing but one large egg, while *dryophila* is without flocculence, the female (according to Huxley) laying many eggs, *Colopha,* considering *ulmicola* as a type, may be accepted as a good genus."

†Fitch Report on the Noxious Insects of N. Y. 347.

leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plates. The gall is always found between two of the branching parallel veins, and those between which it grows are generally drawn closer together than the rest. The corrugations and roughness, so characteristic of this gall, evidently result from the lesser susceptibility of the minute transverse veins to swell, compared with the more succulent tissue of the leaf. There is always a certain hoariness around the mouth of the gall below, while the base of the upper part is always contracted and compressed.

"BIOLOGICAL.

"The impregnated egg of this species is also to be found during the winter in exactly the same sheltered situations, in and under the bark of the White Elm, as that of *Schizoneura americana*. It is almost always sheltered by the dry and somewhat wrinkled skin of the true female, being seldom extruded, but occupying the whole of the body (Fig. 129 *b*). Occasionally the mother skin is more or less freed. The young stem-mothers hatch from the winter egg about the same time, and are minute dark olive-brown specks, just visible to the unaided eye, and quite active during pleasant weather, crawling nimbly about over the tree, till they reach a tender leaf that is just unfolding, when they also settle upon the under surface, and begin to feed on and fret the same. They doubtless insert their beaks in various portions of the buds or expanding leaves ere settling, since, before the gall begins to form, the little architect has generally obtained twice the size it had when first hatched. By the middle of April, in the latitude of Saint Louis, the galls generally begin to show, at first as slight elongate ridges on the upper surface, with corresponding closed depressions on the lower surface. Upon drawing apart the lips of the wrinkle beneath, at this stage of the growth of the gall, the stem-mother, who still retains her glossy olive-brown appearance, is seen constantly running back and forth in the cavity, and inflicting rapid punctures with her beak, the inner surface of her dwelling being smooth and glossy, with a slightly blistered appearance, in contrast with the normal, more rough and pubescent texture of the under surface of the leaf. The development of the gall is very rapid, and, with favorable weather, the top part begins to bulge so as to give the contracted appearance of the base, and the tooth-like prominences begin to appear by the third day. The inmate likewise grows apace. After the first molt, she soon becomes more pyriform and paler, with transverse rows of powdery secretion. She is less active, but still marches about, incessantly fretting the surface with her short, stout beak. A second molt takes place, and by the time the gall has fully developed, or about two weeks from the time it commenced forming, the process of reproduction commences, and continues for two or three weeks, until the stem-mother is exhausted, and the gall is absolutely crowded with this second generation in all stages of growth. The lice are more or less covered and interspersed with the mealy or cottony

excretion, and with the various-sized globules of gummy liquid, which is sometimes so abundant that it will fall upon the ground like a shower of milky fluid, whenever badly infested trees are shaken. The insects comprising this second generation, or the immediate issue from the stem-mother, thus born within the habitation which she had built up, are similar to their parent but somewhat larger at the moment of birth than she was, and of a paler olive-green color. They are quite active within the gall, exploring its concavities, and obtaining their nourishment through its walls. After the second molt, they attain the pupa state, (Fig. 129, *d*), and in due time become winged. There is but one generation produced within the gall—a generation, however, that becomes very numerous under favorable conditions. They all become winged, and in this respect the species differs essentially from *Schizoneura americana* as we have already seen. The winged lice carry their wings flat on the back while in the gall, but deflexed afterward. They issue from the slit on the lower surface of the leaf, which opens for their exit about the time they become fledged. They are all females, and give birth, in the course of a day or so, to upward of a dozen young, which, when first born, are enclosed in the usual delicate egg-like covering already alluded to, and which look like their immediate parent at a corresponding state of existence, except that their antennae have five subequal joints, and the promuscis reaches to the hind coxae (Fig. 129, *c*).

"So far I have been able to trace the history of the species with absolute certainty, watching it for several years, and proving, by extracting the stem-mother soon after she had commenced reproducing, that the second generation, *i. e.*, her immediate progeny, all become winged, the species agreeing in this respect with the gall-making species of *Phyllox cra* that affect the Hickory. There is, however, a link yet wanting in our knowledge of the history of this species, between this third generation and the mouthless sexual individuals, the females of which so often perish while yet covering their solitary winter eggs. I have not been able to prove absolutely that there are two broods of the gall-making female, and my observations all tend to the conclusion that no galls are formed except by the stem-mother that hatches from the impregnated egg. I have never succeeded in obtaining galls either by enclosing the winged females in muslin bags tied on the living trees, or by similarly enclosing her immediate progeny, though I have succeeded in obtaining, without any difficulty, an abundance of galls by so enclosing the stem-mother. Moreover, all such succulent galls as this one are produced on the tender young leaves only, and I have failed to find them on any but those which develop early in the season. It is true that we may frequently find the galls quite fresh, and containing larvae, pupae, and winged insects as late as the first week in July, and these late galls, as well as the insects within them, are generally more yellowish than those found earlier in the year; but a careful study of the structure of the inmates shows them to be identical with those found in the earlier galls, and these late galls are, from present knowledge, to be attributed to the work of late hatching and late developing stem-mothers rather than to

work of the third generation. I am inclined to think that this third generation will be found to have a different habit, possibly feeding upon some other part of the tree, without forming galls, and producing in time the true sexual individuals, something as in the case of the seventh generation of *S. americana*. At all events, the true female (Fig. 129, *b*), with the solitary egg, is to be found about the trunk of the tree, as already described.

"DESCRIPTIVE.

"COLOPHA ULMICOLA.

"*Byrsocrypta ulmicola,* Fitch 4th (sic.)* N. Y. Rep. 1858, p. 63, (§ 347).—*Thelaxes ulmicola,* Walsh. Proc. Ent. Soc. Phil. vol. i, p. 305, 1862; American Entomologist, Vol. i, p. 108, 1869.—*Colopha ulmicola,* Monell, Canadian Entomologist, vol. ix, p. 102, 1877.

"*Impregnated or winter egg* (Fig. 129, *b*).—Length 0.38 mm, perfectly ovoid, shining olivaceous, inclining to brown, with no particular sculpture.

"*First generation, or stem-mother.*—0.4 mm. long when hatched. Antennae 4-jointed, joints subequal in length and thickness, but with the bases of hairs rather strong. Promuscis very short, reaching only to middle coxae or a little beyond. Upper tarsal hairs globate at tip and as long as tarsus. Smooth, dark olive-brown in color with black members. After first molt, the beak is still relatively shorter, as also the tarsal hairs; the color is paler, but the members are still black. She measures 1 mm. in length when beginning to bear, and the third joint of antennae is then somewhat clavate (Fig. 129, *g*), and as long as joints 1 and 2 together; the 4th narrower, as long as 3d, and rather truncate at tip, with two rather conspicuous piliferous prominences. Color translucent yellowish-green, often inclining to purple.

"*Second generation.*—0.4 mm. long when born (Fig. 129, *c*); nearly five times as long as wide; the antennae (Fig. 129, *h*) short and 5-jointed, the joints subequal in length, the 3d shortest and narrowest, the 5th swollen and sub-fusiform, with rather strong bulbs at the base of the hairs. Promuscis reaching to hind coxae. Distinct globate tips to the four tarsal hairs. Color pale olive-green, with black members and a dusky stripe on the notum. *Pupa* (Fig. 129, *d*) with antennae smooth, 6-jointed, joints subequal in thickness, joint 4 only as long as 2; 5 and 6 each twice as long; 3 four times as long. Color dingy orange, with a paler band around the thorax, embracing the wing-pads, and reminding one, on this account, of the pupa of *Phylloxera*. *Winged female* (Fig. 129, *e*): Average expanse 3.7 mm.; the form of body more as in *Phylloxera,* the abdomen tapering and narrower than the thorax, bearing from ten to twenty pseud-ova. Blackish, with an olive green tint, the abdomen and under surface yellowish-green in the fresher individuals. Antennae (Fig. 129, *f*) reaching only to insertion of front wings, 6-jointed; joints 4, 5, and 6 subequal, and together equal to 3 in length.

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*5th.

(Three specimens examined have joints 4 and 5 very imperfectly separated, causing the antennae to appear as 5-jointed). Wings as described by Walsh, the stigma being well rounded and pale. (In three specimens examined, the third discoidal of the front wing is simple and precisely as in *Pemphigus;* in one specimen, the first discoidal is wanting on both front wings, and in another the fork of the third discoidal is wanting on the left one). Basal joint of tarsus rather short; tarsal claws only moderately strong.

"*Third generation.*—The young from the winged female, after being freed from the pellicle in which they were born, have stout five-jointed antennae, the joints subequal; stout but short promuscis reaching to hind coxae; rather large compound eyes. Proportions and shape of young *Phylloxera.*

"*True female:* Legs short and the basal joint of tarsus rudimentary; antennae short, four-jointed, smooth, joints subequal, the third somewhat longest. Mouth rudimentary. Described from skins surrounding impregnated egg. Males unknown."

Thomas (1879) gives for this species besides a systematic discussion, the following characterization:

"*Glyphina ulmicola.* Fitch. The Aphis of the Elm-leaf Cockscomb gall.

"This species forms the cone-shaped galls, so common on the upper side of the leaves of young white elms. These galls, which are often an inch or more in length, vary in height, from one to three-quarters of an inch; they are compressed and grooved on the sides, and perpendicular, showing tooth-like, conical projections at the top: opening by a long slit on the under side. The inside is wrinkled perpendicularly into deep plaits or folds, and occupied by one female and her progeny, some of which may often be seen strolling out on the under side of the leaf.

"My examinations of these insects show the characters of the species to be as follows:

"*Winged individual.*—Length of body about .05 inch, to the tip of the closed wings .08 inch, thorax black; the abdomen dull black or greenish black above; paler, obscure green beneath; slightly pruinose. Antennae very short, scarcely reaching beyond the insertion of the fore-wings; first and second joint very short; third much the longest, about equal in length to the three following taken together, fifth and sixth about equal, all except the basal joints transversely corrugated. Wings transparent, resting somewhat flatly on the abdomen while in the gall, but after the specimens have been removed for a while, will assume the usual erect position, the costal and sub-costal veins dark; the latter robust and undulating; stigma prominent; the first and second discoidal veins are close together; the third obsolete at base, emits the fork about midway its length (counting to the imaginary point of insertion). No honey-tubes; the abdomen expanding near the tip.

"The *wingless individuals* are very short, broadly ovate, and very convex; olive green, covered slightly with a white powder; antennae and legs very short."

As stated under the discussions of *colophoidea* it is not certain whether *ulmicola* and *colophoidea* are distinct species or dimorphic forms of the same species. Recognizing the danger of making a composite species on insufficient basis, I have considered them distinct and think it expedient to do so unless they are definitely proven to be the same, although I find no character except the venation to separate them, M being branched for *ulmicola* and simple for *colophoidea*.

Concerning the stability of the branched M for *ulmicola* the following statements are of interest:

Walsh, who first described the winged form, put the insect in *Thelaxes* (M branched) and figured the *Thelaxes* wing with a branched M. He says, "Dr. Fitch had not seen the winged insect, of which I have obtained many specimens." Mr. Monell erected *Colopha* (M branched) for this insect. In a letter to Mr. J. J. Davis, December, 1908, Mr. Monell wrote: "I have not seen the *Colopha ulmicola* for some years but have examined hundreds of specimens and find venation very constant. I have also examined hundreds of *Tetraneura colophoidea* and find its venation always constant." In a letter to me, February 3. 1910, Mr. Monell wrote: "Riley gave a whole summer to the insect and published the results of his work in the Riley and Monell paper. All this time the *Tetraneura* was unknown. Riley's collecting point was, when he lived about 5 miles west of Saint Louis, at Webster."

Riley, who must have seen many winged specimens, records (1879) only 5 specimens departing from *Colopha* venation. "Wings as described by Walsh, the stigma being well rounded and pale. (In three specimens examined, the third discoidal (M) of the front wing is simple and precisely as in *Pemphigus;* in one specimen, the first discoidal (A) is wanting on both front wings, and in another the fork of third discoidal is wanting on the left one."

Thomas (III Report) describes M branched as did Walsh, "the third (discoidal) obsolete at base, emits the fork almost midway its length (counting to the imaginary point of insertion)."

Cowen (1895) records in a preliminary list of the Hemiptera of Colorado, as though it was exceptional, "*Colopha ulmi-*

cola Fitch. Fort Collins, July 8th, in 'cockscomb' galls on *Ulmus americana.* Five of the specimens examined have the cubital (M) of fore wings simple."

Mr. Sirrine's letter (Feb. 28, 1910) states "the most constant distinction" (i. e., between *ulmicola* and *colophoidea*) "is the forking of the third discoidal."

We have then, Monell, Riley, Sirrine, Thomas, Walsh (certainly competent observers!) all familiar with the species, giving the venation with M branched and Cowen recording 5 specimens with M simple as though they were exceptional.

My personal acquaintance with *Colopha ulmicola* is chiefly limited to the following material:

1. A slide lent me by Mr. Monell collected July 2, 1876, at St. Louis. The slide was labeled "*Thelaxes ulmicola* 157." This material was collected before Riley's paper appeared and was, Mr. Monell states, "certainly either type or co-type of the genus *Colopha.*" There are 4 winged specimens on the slide, the 8 fore wings of which have M branched. Venation perfectly regular.

2. A slide lent me by Mr. J. J. Davis on which were mounted 16 winged specimens collected at LeRoy, Illinois, July 10, 1907. Of these 15 specimens have M of both fore wings branched, and the other has M simple in one wing and an indication of the distal tip of a branch in the other wing. Of the 16 specimens 4 had irregular venation in varying degrees.

3. A slide lent me from the Thomas collection. It contained 1 winged specimen. M of both wings branched, Cu and A of one wing also branched, and a slight stub branching from Cu on the other.

4. A vial with several galls, winged individuals and pupæ lent me from the Thomas Collection. Vial labeled merely "36."

The antennæ of the specimens lent me by Mr. Monell have III, 0.16 mm.; IV, 0.05 mm.; V, 0.06 mm.; VI, 0.065 mm.; approximately. Camera lucida sketch of one of these antenna is given in Fig. 176. The wing expanse is 3.7 mm. The antennæ of the specimens lent me by Mr. Davis have III, 0.19 mm.; IV, 0.05 mm.-0.06 mm.; V, 0.07-0.075 mm.; VI, 0.07 mm.-0.09 mm. A camera lucida sketch of one of these is given in Fig. 178. The wing expanse is 3.6 mm.

5. Slides lent me by Mr. Sirrine containing stem mother, pupæ, and 12 winged forms from cockscomb galls on Cork Elm, I. A. C., 7-4-'93. (Figs. 131, 136, 179).

Besides the foregoing gall material I have examined as given in the following record, the grass form, the winged individuals of which show no distinguishing characters to separate them from the migrants from the gall.

6. *Colopha eragrostidis.* A co-type slide lent me by Mr. Monell, to whom it was given by Miss Middleton in 1877. Two specimens on slide, both of which had M as typical for *ulmicola* though one Cu was abnormal in one specimen. Antennæ as in *ulmicola.*

7. *Colopha* (*eragrostidis*) *ulmicola.* Slides lent me by Mr. Sirrine. Material comprises 1 apt. vivip. form and pupa from roots, several pupæ and 9 winged forms from blades of *Eragrostidis* sp. Slides bear the dates of 9-28-'92, 10-8-'92, 9-9-'93, 9-20-'93. Collections made in part at Squaw Creek. Wing and antennal characters as in co-type slide of *eragrostidis* and as in *ulmicola.* (Figs. 130, 132, 180).

The October collection evidence of Osborn and Sirrine, the statement of Riley in regard to the identity of *ulmicola* and *eragrostidis* and the structural evidence of the mounted specimens from the various sources at hand during the present study are conclusive enough, I believe, to make *eragrostidis* definitely a synonym of *ulmicola.* For the important experimental evidence recorded in letter of Mr. Sirrine the reader is referred to page — of this bulletin.

Following is given the original description of *eragrostidis* by Miss Middleton which was printed in 1878 in Bulletin No. 2 of the Illinois State Laboratory of Natural History:

"*Colopha eragrostidis,* new sp.

"*Winged individual.*—General color reddish-brown; head black; prothorax yellowish, rest of the thorax and abdomen reddish brown; veins of the wings dark; stigma pale brown.

"*Wings,* when first seen horizontal, but becoming erect, formed and veined as usual; the third vein in the anterior pair with only one fork and obsolete nearly half way to the base of the fork; the first and second veins approximate very closely at the base. Posterior pair with but one discoidal vein.

"*Antennae* six jointed, with the sutures between the third and fourth and between fifth and sixth transparent; first and second joints short; third about equal to the fourth, fifth and sixth united; the fourth and

fifth nearly equal in length; sixth very short, but little exceeding the first and second united. The antennae as compared with the body are very short, scarcely reaching to the base of the front wings; not tapering.

"*Wingless individual.*—Body covered with a cottony substance; beak short, not extending to the base of the second pair of legs. No honey-tubes. Length of the body .06 of an inch; to tip of wings .10 of an inch. (sic.)*

"This species was found September 1st, 1877, on the upper leaves and fruit stems of a species of grass (*Eragrostis poaeoides* var. *megastachya*), the blades of the grass folding over the insects.

"It is also found on some species of *Panicum*.

"This evidently belongs to Mr. J. Monell's new genus *Colopha,* as the third vein of the front wing is but once forked, the hind wings have but one discoidal vein, and the antennae are six-jointed."

Bibliography.

It is with some hesitancy that I attempt a bibliography for *ulmicola*. Mr. Monell (The Can. Ent. IX, page 103) refers to such bibliography of this species as appeared before 1877 as a "Comedy of Errors," and as Mr. Hunter's list (1901) contins eight errors (some minor) the cock's comb gall louse is still apparently a difficult species in a literary way. Eight or more authorities who have attempted references have added to the confusion. The following list is therefore offered somewhat timidily, though hopefully. The accounts which I have not personally seen are cited in ( ). For the accuracy of the others I am responsible.

1858 (Pub. 1859). Brysocrypta ulmicola Fitch. Fifth Report Ins. N. Y. Trans. N. Y. St. Agric. Soc. Vol. XVIII, p. 843, paragraph 347 (63rd page of 5th Report, paragraph 347). Original description of galls, stem-mother, and nymphs.

(1861. ——— ——— Osten Sacken, Stett. Ent. Zeit. *22*: 422).

1862. Thelaxes ulmicola Walsh, Proc. Ent. Soc. Phil. Vol. I. pp. 304, 305, original description of winged form. p. 297, Fig. V. and table.

(1866. ——— ——— Walsh, Pract. Ent. *1*: 114; *2*: 8.)

1869. Thelaxes ulmicola, Walsh and Riley. American Entomologist. Vol. I, p. 108. Description of insect and gall and Fig. 90 of gall. Also p. 224 mere mention.

1869. Thelaxes ulmicola, Packard. Guide: p. 523.

"Pemphigus ulmicola of Fitch" Packard. Guide: P. 524-525,

*So it stands in the original description but it is evident that these measurements were taken for the *winged* and not *wingless individual.*

with Fig. 525 (after Walsh and Riley) and brief quotation from Walsh and Riley, American Entomologist, Vol. I, p. 108.

(1874. ——— ——— Riley. N. Y. Tribune, July 22, p. 17).

1877. Colopha ulmicola (Fitch) Monell. Monell. Can. Ent. *9*: 102. Original description of genus and comments on bibliography.

(1877. Pemphigus ulmicola. Emily A. Smith. Shade Trees, indigenous shrubs and vines, and insects that affect them. Peoria, Ill.)

(1878. Brysocripta (Glyphina) ulmicola, Lintner. Country Gentl. July 18. *43*: 455. Brief account.)

1879. Colopha ulmicola, Riley. Bull. U. S. Geol. Surv. Vol. V. No. 1, pp. 9-13. Fig. 2, a-g. Biological and descriptive.

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1906. Colopha ulmicola, Folsom. Entomology. Fig. 249. Photograph of galls on leaf. p. 255.

1906. Colopha ulmicola, Felt. Insects Affecting Park and Woodland Trees. N. Y. State Museum Memoir 8. pp. 172, 186-87, 247, 620, 633.

1878. *Colopha eragrostidis* Middleton, Bull. Ill. Lab. Nat. Hist. No. 2. p. 17. Original description.

1887. *Colopha eragrostidis,* Oestlund Aphid. Minn. p. 29. Listed for America.

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1893. *Colopha eragrostidis,* Riley. Insect Life *5*: 235 foot note. Considered identical with *ulmicola.*

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TETRANEURA GRAMINIS COLOPHOIDEA

Tetraneura graminis Monell.
Tetraneura colophoidea Monell mss.
Tetraneura ulmi Osborn-Sirrine. Not Linn.
Tetraneura ulmi Sanborn. Not Linn.
Tetraneura colophoidea Howard.
Tetraneura ulmicola Gillette.

(Producing a cockscomb-shaped gall on the dorsal side of leaf of *Ulmus americana.* Fig. 126).

Descriptive.

First generation,—apterous viviparous stem mother. Eyes in a group of three ocelli on each side of head. Head, thorax, and abdomen translucent, pale yellow and pulverulent. Head sometimes a little smoky. Antennæ, beak, and legs (femora, tibia, and tarsus) dusky. Beak short, not reaching second coxæ. Antenna 4-jointed (sometimes 5-jointed by a faint division of III). III about the length of I+II and about twice as long as IV. In the specimen measured, I, 0.05 mm.; II, 0.04 mm.; III, 0.1 mm.; IV, 0.05 mm. Total length of large individual, 1.57 mm. Color description from live mature specimens examined July 8, 1909, measurements from balsam mounts. At this date in some galls the stem mother was still plump, in others much shrunken. Habitat,—single stem mother with progeny in cockscomb gall on *Ulmus americana.* Figs. 172 and 173. Maine collection numbers aphid 23-09, aphid 57-09, aphid 65-09.

Apterous viviparous form not stem mother. Head and thorax white, abdomen greenish. Eyes, antennæ and legs dusky. Antenna 6-jointed. I, II about subequal; III, IV, V about subequal, each being shorter than II; VI about equal to IV+V and longer than II. I, 0.03 mm.; II, 0.035 mm.; III, 0.029 mm.; IV, 0.027 mm.; V, 0.025 mm.; VI, 0.055 mm. Beak short, not reaching second coxæ. Total length of body, 1.5 mm. This form when removed from the gall propelled itself with a humping motion by curling under the tip of the abdomen and using that as an aid in locomotion. Color description from live mature specimens taken July 14, 1909, measurements from balsam mounts. Habitat, 1 or 2 frequently found in cockscomb gall on *Ulmus americana* in company with stem mother and pupæ of *T. colophoidea.*

Described from 6 specimens. Figs. 133, 174. Maine collection number Aphid 65-09.

Second generation,—migrants. Abdomen and ventral body greenish black, abdomen pulverulent, antennæ, head, thorax and legs black. Wings as typical for *Tetraneura,*—M unbranched in fore wing and Cu wanting in the hind wing. Veins and stigma are dark. Wing expanse about 4 mm. Antennæ with IV, V, VI approximately subequal. III, 0.175-0.195 mm.; IV, 0.075-0.085 mm.; V, 0.065 mm.; VI, 0.055-0.063 mm. III with an average of 12 partial annulations. IV with an average of 6 partial annulations. V with an average of 4 partial annulations. VI comparatively smooth though with irregular annulations frequently present, especially at base of unguis. (Figs. 169, 170).

This generation while in the young nymphal stage are yellow and colored like stem mother except that the eyes are red. Pupæ about ready to molt have head, prothorax, and abdomen dark bluish black. Antennæ 6-jointed (Fig. 171). Antennæ, legs and thorax are much paler and the wing pads are a translucent smoky white. Eyes black. Color description from live specimens examined July 8, 1909. Habitat, developing in cockscomb gall on *Ulmus americana* and migrating from elm upon leaving gall. Maine collection numbers aphid 57-09, aphid 65-09.

———? *generation. Larvæ.* Beak reaching to 2nd coxæ. Antenna 5-jointed with V very uneven and ragged at tip. See

Figs. 143, 144, 145. Described from 3 balsam specimens of material collected by F. A. Sirrine, 9-30-'92. Habitat, roots of grass, *Leersia virginica*.

———*? generation.* "*T. graminis* n. sp. Head and thorax dusky, abdomen dusky or sometimes of a greenish or yellowish tinge. Antennæ dusky, the third joint as long as the three following taken together; joints four and five equal; apical joint a little over half as long as the preceding. Wings hyaline. Subcostal of the hind wing comparatively straight.

Length of body .08, to tip of wings .12 in.

On leaves of *Aira cæspitosa* and *Agrostis plumosa,* enveloped in a thick cotton-like secretion.

Sept.-Oct. St. Louis, Mo., Springfield, Mo., Neosho City, Mo."*

See Fig. 134. A slide lent by Mr. Monell labeled "43" contained a specimen collected October 11, 1876, has a wing expanse of 4.4 mm. and antennal measurements I, 0.035 mm.; II, 0.035 mm.; III, 0.2 mm.; IV, 0.07 mm.; V, 0.06 mm.; VI, 0.055 mm.

The *return migrants* (*sexuparæ*) on leaves of *Leersia viginica* and specimens alighted on bark of elm, lent me by Mr. Sirrine accords with material lent me by Mr. Monell.

The pupæ on *Leersia virginica* (Sirrine material) have a 6-jointed antenna with III about as long as IV+V. IV, V, and VI are subequal. This accords with the pupal antenna of *T. graminis* (*colophoidea.*)

———*? generation. True sexes.* Without beaks. Female: Antennæ 4-jointed with a peculiar thumb-like projection on IV (Fig. 181). Legs with long capitate hairs (Fig. 182). Length 0.55 mm. Male shorter; more slender. Described from balsam mounts lent by Mr. Sirrine of material taken on bark of *Ulmus americana,* I. A. C. 10-4-'92.

BIOLOGICAL.

A single stem mother occurs in each gall and her progeny up to the time of the migration (July 8-14, 1909, Orono, Maine) are about 70 in number, consisting in nymphs (destined to become winged); pupæ, and newly winged forms. At this time

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*Can. Ent. Vol. XIV. Jan. 1882, p. 16. Original description quoted entire.

some of the stem mothers are still plump and actively producing, in which case very young nymphs occur in the gall together with the newly winged forms not yet migrated, while other stem mothers are much shrunken and no longer producing. On June 19, 1909, most of the stem mothers were in the last instar but not yet producing.

Besides the stem mothers and migrating progeny there are sometimes 1 or 2 apterous viviparous individuals in the gall. (Figs. 133, 174, 175). The counts I made of Maine material gave these at the rate of 2 for 13 galls. They were maturing at the same time as the older of the migrants,—as was shown by the embryos in their abdomens. What possible part these forms play in the life history of the species I am unable even to guess. There is the possibility that these are some distinct species of aphid which has crowded into the opening of the gall as guest. If so it is some species I have never taken in any other connection. It is certainly desirable that nymphs produced by this form be reared through to the winged stage.

The migrants after molting leave the gall through the opening slit on ventral leaf. Their immediate fate has not been followed but there is no doubt that they seek some species of grass on which to deposit their young. It is indeed *Tetraneura graminis* Monell which Mr. Monell has long considered to be the grass form of *Tetraneura colophoidea*.*

From the Sirrine slides it seems likely that the nymphs live upon the grass roots and that the pupæ crawl up and settle upon the grass blades before molting.

The return migrants, according to the collection recorded by Osborn-Sirrine, like those of *Colopha ulmicola,* seek the bark of the elm in the fall and deposit the true sexes which produce the winter eggs. "Winged forms of *Tetraneura graminis* were found flying from *Leersia virginica* and at the same time winged specimens of *Tetraneura ulmi*" (here=*colophoidea*) "were observed alighting and hiding under rough bark of the elm; where afterwards the peculiar males and females of the latter were found as also the single egg of the female."*

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*This is the species suggested to be the same as *graminis* by Osborn-Sirrine (1893) but as it was listed by them under the name of *ulmi* this record has been somewhat confusing.

*Proc. Ia. Acad. Sci., Vol. I, Part 3, pp. 98-101.

At the time of preparation of this paper I have six slides of this species lent me by Mr. Sirrine. One slide is labeled "*Tetraneura ulmi,* winged adult, and pupa and stem mother. From cocks comb gall on *Ulmus americana.* I. A. C. 6-27-'93." The specimens accord with Maine specimens of *Tetraneura colophoidea,* and the winged forms accord with a slide of *T. graminis* lent me by Mr. Monell. The Sirrine material also comprises *Tetraneura graminis,* larvæ, pupæ, and winged adult collected from blades of grass, *Leersia virginica* and larvæ from roots of same. Also migrants which had alighted on the bark of *Ulmus americana* and their progeny, true males and females (see figures) and an egg. The collections from grass were labeled "I. A. C. 9-30-'92" and "I. A. C. 9-13-'93." The specimens collected from elm trunk are dated "I. A. C. 10-4-'92."

A careful consideration of the evidence at hand and the comparison of the identical material recorded by Osborn-Sirrine with Maine material of *colophoidea* and the comparison of it all with the Monell slide of *Tetraneura graminis* convince me that these are all the same species. The evidence of the return migration and the structural evidence certainly seems sufficient to establish their identity. Moreover the experimental evidence in the following letter gives interesting testimony.

RIVERHEAD, N. Y., March 14, 1910.

My Dear Miss Patch:—

Replying to your letter regarding the colonization of *Tetraneura* and *Colopha;* I succeeded in colonizing *Tetraneura* on *Leersia* and *Colopha* on *Eragrostis.* The transfers were made by transplanting the grasses to pots and growing same under lantern-globes in forcing house. As soon as the migrants in the galls showed winged specimens, the galls were placed on the pots under the jars allowing the migrants to find the host plants themselves. Galls containing *Tetraneura* were placed under jars containing *Leersia,* also under jars containing *Eragrostis.* Galls containing *Colopha* were treated in same way.

Unfortunately the larvae of the migrants were not carried to maturity in confinement, nor the number of summer broods on annuals determined. At the time I had class work and other field work to look after. Those who had charge of the forcing house neglected to ventilate one hot day and I found things cooked.

The two species were found in field at same time and frequently during the summer; but if you can carry them through the summer in confinement and determine number of broods, do so.

Sincerely yours,

F. A. SIRRINE.

Discussion.

The introduction of the gall form of this species is of peculiar interest. Perhaps no aphid gall is more generally familiar than the cockscomb gall of the elm. This gall has always been associated in our literature only with *ulmicola*. It was, therefore, with considerable surprise that I found that the species emerging from the cockscomb gall in Maine in 1909 was not a *Colopha* but a true *Tetraneura* by virtue of its venation—M being constantly unbranched. After examining 2,000 wings (1,997 of which had M simple) to be sure of a safe basis, I found I was confronted with the dilemma, either two species of aphid occur in similar cockscomb galls on the elm or *Colopha ulmicola* is dimorphic. As there are no well established specific characters sufficient to separate *ulmicola* and *colophoidea* except the venation, there is as yet no positive proof as to which is the case. But as both *ulmicola* and *colophoidea* show constant venation in certain large collections, the former with M branched and the latter with M simple, it is certainly desirable to treat them as distinct for the present. Especially is this true because *Tetraneura graminis* is shown* to be the grass form of *Tetraneura colophoidea* and a sweeping amalgamation of four species is not desirable without very definite biological proof.

Tetraneura colophoidea has a manuscript history of no slight interest as is indicated in the following extracts from Mr. Monell's recent letters:

"*Tetraneura colophoidea* inhabits a cockscomb gall agreeing exactly with my recollection of *Colopha ulmicola*. * * * About 1886 at Washington, Pergande first discovered the *Tetraneura* and a few years ago I discovered it here (at St. Louis, July 7, 1906). * * * *T. colophoidea* is a mss. name that got into print,† I do not know just how. Pergande says I used it years ago but I have no recollection of it. * * * A good many years ago I had some correspondence with Pergande regarding the *Tetraneura* that makes galls similar to *Colopha ulmicola* (= *compressa* Koch ? ? ?) and suppose this term *colophoidea* may have been used in correspondence then. Certainly nothing was ever published by me. * * * So I have no objection if you describe it as *colophoidea* Monell mss. I also see no objection to ignoring the *colophoidea* and giving the species any name you desire. * * * It has been my opinion that *Colopha eragrostidis* is one of the stages of *C. ulmicola* (or *C. compressa* Koch as Lichtenstein would call it) and

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*See page 212.

†Ent. News, October, 1908, p. 365.

that *Tetraneura colophoidea* with similar elm galls is the same as *Tetraneura graminis* Monell. * * * That there are grass forms of these genera is one of Lichtenstein's old theories. Osborn and Sirrine give a note of all these species 'Notes on Aphididae' in Proc. Ia. Acad. Science Vol. I, part III, pp. 98-101. * * * I suppose by *Tetraneura ulmi* they mean *Tetraneura colophoidea.* * * * This *Tetraneura* has been referred to *T. ulmi* in divers publications but it is distinct. I have seen one European gall of *T. ulmi* of Europe raised from European eggs. See Can. Ent. January 1882, page 16. Monell 'Notes on Aphididae'* I do not remember now whether I ever got any winged specimens. I do not think there is any other authentic record of *ulmi* in U. S. * * * I have examined hundreds of specimens of *Colopha ulmicola* and find venation very constant. I have also examined hundreds of the *T. colophoidea* and find its venation always constant. * * * I think they are distinct, and yet they may be dimorphs."

The name *Tetraneura colophoidea* was printed in a paper "Upon the Aphis-feeding Species of Aphelinus" by Doctor Howard in the Entomological News, October, 1908, p. 365, and in response to inquiry concerning this species by Mr. J. J. Davis, Doctor Howard wrote him, December 9, 1908,—"Mr. Pergande reports that the name *colophoidea* was a provisional manuscript name given to the insect in question some years ago by Mr. J. Monell. It has never been published so far as Mr. Pergande knows."

This insect was described and figured under the name *Tetraneura ulmi* by Mr. C. E. Sanborn* and a description by Mr. Burrows of the cockscomb gall from which it emerges is included in Mr. Sanborn's treatment of this insect. That his species is not *T. ulmi* of Europe is apparent from the description of the gall, and from the venation it is apparent that it is *colophoidea* and not *ulmicola* which he figures.

Mr. Sanborn very kindly sent me specimens of this species collected June 21, 1904, by Mr. Burrows at Lawrence, Kansas. The material was labeled *Tetraneura ulmi* DeG., under which name the description of the winged form and gall are recorded in *Kansas Aphididæ.* The specimens sent me accord with *Tetraneura colophoidea* as I have found it in Maine.

Osborn and Sirrine (1893) suggest the identity of *Tetraneura "ulmi"* and *graminis.* As a slide of winged *graminis* lent me

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*"I have succeeded in raising *T. ulmi* at St. Louis from eggs sent to me by Mr. Kessler of Cassel. They seem to thrive the first season but did not appear again the next year."

*Kansas Aphididae. p. 23 and Plate V, Fig. 34.

by Mr. Monell clearly established the fact that *graminis* is certainly distinct from *ulmi* of Europe but not apparently different from *colophoidea,* I wrote Mr. Sirrine, who very kindly sent me slides of both the elm species recorded in 1893 and elucidating notes. Extracts from Mr. Sirrine's letter February 28, 1910, read:

"I am sending you half a dozen slides each of *Tetraneura ulmi -graminis* and *Colopha ulmicola-eragrostidis.* Both *Tetraneura* and *Colopha* produce cockscomb galls on the elm, but those of *Tetraneura* occurred on *Ulmus americana* while those of *Colopha* were on *Ulmus racemosa.* One note states '*Colopha* and *Tetraneura* occupy the same kind of galls on elm. Are they dimorphic'? I found later that I had apparently collected leaves of both *Ulmus americana* and *racemosa* without distinguishing the difference. Furthermore I did not succeed in getting *Colopha* to colonize on *Leersia virginica* nor *Tetraneura* to colonize on *Eragrostis* sp. From the specimens sent you will see that the most constant distinction is the forking of the 3rd discoidal while the distance between the bases of the 1st and 2nd discoidals, the lengths of the antennae and body are less constant. Possibly the use of the name *Tetraneura ulmi* for a species producing a cockscomb gall while the *Tetraneura ulmi* DeGeer, described by Buckton produces a pedunculated gall, may be confusing. The following is copied from notes: '*Colopha ulmicola eragrostidis* is lighter in color than *Tetraneura ulmi graminis.* The latter has abdomen olive green with yellow tinge due to body contents, body linear throughout, thorax dusky instead of black. *Colopha* abdomen yellow with reddish tinge, head and callosities black, remainder of thorax yellow.' "

In order to secure a safe basis for characterizing the wing venation of this species 2,000 wings were examined of which 13 were abnormal in some respect. Sketches of these 13 wings are given in figures 185-197, together with a sketch of a normal wing (fig. 184). We had 1,000 specimens, 987 of which had normal venation on both sides, the remaining 13 had normal venation on one side. It will be noted that of the 2,000 wings, 1,997 had M unbranched as is typical for *Tetraneura.* This count was made from a haphazard collection of galls from *Ulmus americana* taken July 14, 1909, Orono, Maine, under the aphid number 65-09.

Bibliography.

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1901. *Tetraneura graminis,* Hunter Aphid. of N. A. Bibliography and host plants.

1886? *Tetraneura colophoidea* Monell mss.

1893. Tetraneura ulmi, Osborn-Sirrine, Proc. Ia. Acad. Sci. 1, pt. 3: 100 (Ins. Life 5: 237). Identity of *"ulmi"* (= *colophoidea*) and *graminis* suggested.

1904. Tetraneura ulmi, Sanborn. Kansas Aphididae, Part I, pp. 23-24, and Plate V, Fig. 34. Description of gall and description and figure of migrant. (Name by error as is seen from description and reference). This is the first description of *Tetraneura colophoidea.*

1908. *Tetraneura colophoidea,* Howard. Ent. News, October, 1908. p. 365. Merely listed in paper *"Upon the Aphis-Feeding species of Aphelinus."*

1909. *Tetraneura ulmicola,* Gillette. Journ. Ec. Ent. Oct. Figs. 1, 2, antenna.

TETRANEURA ULMISACCULI n. sp.

Tetraneura sp.* Patch.

(Producing an erect pedunculated gall on the dorsal side of leaf of *Ulmus montana* var. *Camperdown pendula.* Fig. 127).

Descriptive.

First generation,—apterous viviparous stem-mother. Head greenish black with bronze tint. Eyes in a group of three ocelli on each side of head. Antennæ dusky, 4-jointed, I, 0.035 mm.; II, 0.035 mm.; III, 0.1 mm.; IV, 0.055 mm. Beak extends nearly to 2nd coxæ. Prothorax, thorax and abdomen dark green with slight purple tint. Femora, tibia, tarsus dusky. Length of body 2.35 mm.; abdomen globular. Greatest width of abdomen 1.7 mm. Measurements from balsam mounts. Color description from live mature specimens examined July 6, 1909. At this date stem mothers still plump and producing in some galls, in others much shrunken.

Habitat,—single stem mother with progeny in gall. (Figs. 167, 168). Maine collection number of type specimens aphid 53-09.

Second generation,—migrants. Head black. Antenna black, 6-jointed with III, IV, V with heavy annulations, I, 0.05 mm.; II, 0.055 mm.; III, 0.24 mm.; IV, 0.065 mm.-0.08 mm.; V,

*1909. Homologies of Wing Veins of the Aphididae, Psyllidae, Aleurodidae, and Coccidae. Ann. Ent. Soc. of Am. Vol. II, No. 2. Plate XVII, Fig. 17.

0.13 mm.-0.145 mm.; VI, 0.085 mm.-0.095 mm. Annulations not completely circling the joints, these vary in number but are approximately III, 9 to 11; IV, 2 to 3; V, 6; VI, 3. Annulations on VI faint, very irregular and often run together. Beak extends a little caudad of 1st coxa. Thorax dark dorsally and ventrally. Wings with venation as usual for *Tetraneura*. Veins dark and heavy, Cu and 1st A being conspicuously heavier than the others, stigma dark. Wing expanse 6 mm. Abdomen dark green. Total length of body 2.15 mm. Measurements from balsam mounts. Color description from individuals removed from gall before flight, July 6, 1909. They grow even darker with age.

Habitat,—about 60 individuals developing in gall as progeny of single stem mother and after attaining wings migrating from gall. (Figs. 164, 165).

Maine collection numbers of type specimens Aphid 22-05, Aphid 53-09.

Pupæ. The second generation while in the pupal stage vary from dark purplish individuals to light individuals having dusky head and prothorax; white pellucid thorax, wing pads, antennæ, and legs; and pale tan abdomen. Body somewhat flocculent. Antenna 6-jointed. (Fig. 166). Aphid No., 53-09.

Galls. The galls are pedunculated sacs with height of from less than ½ to 1 inch. They are bright yellowish green with a varnished look and much paler than the elm leaf. The older galls have some pinkish tints. The opening into the gall which is on the ventral side of leaf is surrounded with pale fuzzy hair which extends a short distance up into the gall. Inside wall of gall with slight longitudinal ridges. The galls occurred in numbers from 1 to 36 on single leaf. Where most numerous some of the galls were small and not typical in shape. They occur on the dorsal surface of leaf between the lateral veins. No galls were found exactly on the mid rib, though they were often very near. The mature gall as a rule had an irregular circular hole in the side through which the migrants made exit.

Biological.

On June 26, 1909, the galls about Orono were pretty well grown. Most of the stem mothers at this date were not quite mature,—had not begun to produce. By July 6 some of the stem mothers were shriveled and were through producing, oth-

ers were plump and still producing though the older of the progeny were pupæ about ready to molt. At this date the migrants in some galls were already winged. At this time most of the galls pop open on one side, a circular hole for exit being thus provided. The opening into the gall from the ventral side of the leaf was apparently used for exit in the galls of less vigorous growth which did not split on the side. So far as the examination of many galls revealed all the progeny of the stem mother acquired wings, no apterous form except the stem mother being found in any gall examined.

The migration took place the last of June and first of July, but the fate of the migrants and their progeny was not ascertained. It is probable that they, like the European elm *Tetraneura* and *Tetraneura graminis,* accept some grass species for the summer host and that migrants from grass return to the elm in the fall to deposit the true sexes which consign the winter egg to the crevices of the bark.

Discussion.

Galls of this species I have collected at Orono, June 30, 1904; July 3, 1905; June 26-July 6, 1909, and specimens of galls with winged individuals were sent me from North Berwick, Maine, July 12, 1906. The species of the elm was not recorded except for the 1909 collection which was made from an ornamental elm, *Ulmus montana* var. *Camperdown pendula.*

I do not know that *ulmisacculi* will prove to be distinct from European species. But the European literature on the *Tetraneura* of the elm,—*ulmi, alba* and *rubra,* is not definite even for Europe, and it is certainly not desirable to add to the confusion already existing by trying to merge *ulmisacculi* with any of them unless the identity can be definitely proven. A brief discussion of the difference between *ulmisacculi* and the European species is of interest in this connection.

"Deep red hairy galls"* would be sufficient to exclude *ulmisacculi* from *rubra.* Lichtenstein (1880) gives in his table "Insect white, stem mother with 4-jointed antenna," for *T. alba,* which would exclude *ulmisacculi,* as this is a decidedly dark and not a pale species. In the same table Lichtenstein gives "Insect black, the stem mother with 3-jointed antenna,"

*Buckton, Vol. III, 131.

for *T. ulmi,* which would exclude *ulmisacculi,* the stem mother of which has a 4-jointed antenna. Buckton's description of both insect and gall of *ulmi* accord fairly well with *ulmisacculi,* however, and it is possible that *T. ulmi* Buckton is not *T. ulmi* of the continent but the same as *ulmisacculi.*

TETRANEURA ULMI

There are the following records of *Tetraneura ulmi* in America. As is elsewhere shown in this present paper, there is no evidence that any one has taken authentic specimens of *ulmi* of Europe in America except Mr. Monell, who introduced demined material from Europe but did not succeed in rearing this species except the first year.*

1883. *Tetraneura ulmi,* Monell, Can. Ent. *14*: 16. Brief record of introduction.
1887. *Tetraneura ulmi,* Oestlund. Aph. Minn. p. *24*. "Recorded as American though not yet found in Minnesota."
1890. *Tetraneura ulmi,* Packard. Forest Insects, p. 283. Listed for elm.
1893. *Tetraneura ulmi,* Osborn-Sirrine *not* Linn. Proc. Ia. Acad. Sci. *1*: pt. 3, 100 (Insect Life 5: 237). Name used for the cockscomb *Tetraneura* (*T. colophoidea graminis*) not *ulmi* of Europe.
1901. *Tetraneura ulmi,* Hunter, Aphid. of N. A., p. 76. Bibliography.
1904. *Tetraneura ulmi,* Sanborn *not* Linn. Kansas Aphid. pp. 23-24, Plate V, fig. 34. Description of the cockscomb *Tetraneura,* (*T. colophoidea graminis*) not *ulmi* of Europe.

Some of the more important European references to ulmi are as follows:—

Tetraneura ulmi, Uebers, *3*: 58 pl. 4, f. 15-17.
Tetraneura ulmi, Burm. Handb. *1*: 91.

1843. *Tetraneura ulmi,* Kalt. Mongr. 189.
1844. *Tetraneura ulmi,* Ratzeburg. Forst-Insecten. Dritte Ordnung. pp. 222 and Taf. XIII, F. 2.
1857. *Tetraneura ulmi,* Koch, Pflanzenläuse 288, f. 358, 359.
1878. *Tetraneura ulmi,* Kessler *Die Lebensgeschichte der auf Ulmus campestris vorkommenden Aphiden-Arten.*
1879. *Tetraneura ulmi,* Courchet. *Etude sur les Galles produits par les Galles produits par les Aphidiens.*
1880. *Tetraneura ulmi,* Kessler. *Neue Beobdachtungen an den auf Ulmus campestris vorkommenden Aphiden Arten.*

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*"The eggs of *T. ulmi* from Kessler were on a piece of bark which I tied to a small cultivated European Camperdown weeping elm, at St. Louis, Mo.," according to a recent letter from Mr. Monell.

1880. *Tetraneura ulmi,* Lichtenstein, *Les Pucerons des Ormeaux. La Feuille des Jeunes Naturalistes.* Aout Sept. pp. 1-7.

1881. *Tetraneura ulmi, Buckton.* British Aphides. Vol. III, pp. 131-135, Plate CXIV, figs. 5-13.

1895. *Tetraneura ulmi,* Judeich und Nitsche. *Forst-insektenkunde* Band II, p. 1208 and Fig. 329 c.

1896-1897. *Tetraneura ulmi* DeGeer, Cholodkovsky. *Zool. Anz.,* 1896 No. 520, pp. 508-513; (rev. in *Zool. Centbl.,* 4 (1897), No. 26, pp. 918-919. By O. Nüsslin (Karlsruhe).

(1899) *Tetraneura ulmi,* Cholodkovsky. *Zool. Anz.,* 22 No. 602, pp. 468-477. Descriptive and biological notes on several species of plant-lice.

1902. *Tetraneura ulmi,* Kerner. *Nat. Hist. of Plants.* Vol. II, p. 533. Figure of galls.

1902. *Tetraneura ulmi,* Connold. *British Vegetable Galls.* pp. 247-248. Plate 108. Description and photograph of galls.

PEMPHIGUS ULMIFUSUS

(The Red-Elm Gall-louse produces an erect spindle-shaped gall about 1 inch in height on the upper side of the leaf of the red or slippery elm,—*Ulmus pubescens* Walt., *fulva* Michx. Fig. 150).

This insect which was named in 1869 with only a few words of descriptive comment, remained with no real description until 1904, when it received that attention under the name of *Schizoneura* sp. by reason of a specimen with a branched M as is not infrequent for this species. The appended bibliography gives a brief outline of the character of the discussions, for the most part meagre, which have been given this species during the 40 years since it was recorded by Walsh. So far as has been authentically determined the gall is known to occur only on the red or slippery elm,—*Ulmus pubescens* Walt., *fulva* Michx., and the accounts which record it from *Ulmus americana* are probably in error.

My own acquaintance with this species is limited to Minnesota material given me by Professor Oestlund and Illinois material loaned me by Mr. Davis from the Thomas collection and his own recent collections. From these, I was able to make the following measurements and present figures 146-150.

Total body length 2.15 mm. to tips of closed wings, which is approximately the same as Walsh's 0.07 inch for the same measurement. Wing expanse 3.8 mm.-4.5 mm. Antenna 6-jointed; III, 0.22 mm.-0.26 mm.; IV, 0.09 mm.-0.1 mm.; V,

0.12 mm.-0.14 mm.; VI, 0.13 mm.-0.16 mm.; III exceeding IV+V and less than V+VI. Annulations III, 18-22; IV, 4-7; V, 7-10; VI, 9-11. The antenna of the pupa previous to the molt shows, through the smooth pupal segments, the annulations of the mature insect like a coiled wire (fig. 149).

The wings (fig. 146) are normally as usual for *Pemphigus,* but M in this species is not very stable, a branch of this vein being not uncommon which gives us the wing of a *Schizoneura.* Fig. 147 gives a weak example of this where M is branched merely at the tip. This tendency was commented upon by Walsh in his first record of the insect. Professor Oestlund states that it is a very common tendency in Minnesota, and the slide from him which is labeled "125/'98 (383) B-64. 7/12" has 3 winged specimens, one of which has M branched in both wings and the other two have M simple on one side and branched on the other. Of 18 specimens collected by Mr. Davis, 7 July, '07, Leroy, Illinois, 4 specimens had M branched on one side and one other had one M and one Cu branched.

The gall which was used for Fig. 150 is over 1¼ in. (35 mm.) long. Besides this I have seen only 4 or 5 galls of this species from Minneosta and Illinois, none of which were so large. Mr. J. J. Davis measured one gall of *P. ulmifusus* collected at Villa Ridge, in Southern Illinois, June 4, 1892, and found it to be 22 mm. long, 6½ mm. wide at widest point and 2¼ mm. wide at the neck.

Mr. Sanborn quotes the following description of the gall, which is the best available, for which reason I am glad to make use of it in this connection:

"This gall occurs on the dorsal side of the leaf of the elm (*Ulmus americana*?). The gall is large and elongated, tapering at both ends; sides sunken and irregular, due to the thin wall of the central cavity; 2½ c. in height and 1 c. m. at its greatest diameter. The walls are of a leathery texture, green when young, turning to a straw color upon reaching maturity. The gall is firmly fastened to the leaf. The internal side of the gall is covered with plant-lice which emerge through a crack which occurs along the side of the gall, or some few through the small opening on the ventral side of the leaf."

The original "description" occurs in an incidental manner in a foot note and as it is no longer easily accessible it is quoted entire as follows:

"The Red Elm, or Slippery Elm, as we have ascertained by close and long-continued observation, never bears these cockscomb-like galls. But

there is occasionally found upon the upper face of its leaves in small numbers, a solitary gall with quite a thin rind, about an inch long, shaped much like one of those depicted in figure 86,* and hitherto undescribed. It is made by a species of plant louse belonging to the same genus (*Pemphigus*) as Fig. 88.† In Europe a well known elm-gall (*ulmi*) is made by another genus of Plant-lice (*Byrsocrypta,* Haliday = *Tetraneura,* Hartig). So that on the same genus of trees, the Elm, we have three distinct galls made by three distinct genera of plant-lice; the more general rule being that the same genus of gall-makers attacks the same genus of plants. The above described gall on the Red Elm which we may call the Spindle-shaped Elm-gall (*Ulmi fusus*), was first brought to our notice by Dr. W. M. Smith of New York; but we have since found several specimens in South Illinois. The winged insect (*Pemphigus ulmi-fusus,* n. sp.) which only measures 0.07 inch to the tips of the wings, and is of a uniform dusky color, occurred July 11th. Out of 28 specimens, two have both wings, and one a single wing veined precisely like those of *Eriosoma* (Fig. 70, c. p. 82)—thus affording a practical exemplification of how one genus of plant-lice may gradually in the course of indefinite ages merge into another."

Bibliography.

1869. *Pemphigus ulmifusus* Walsh:—Am. Ent. Vol. 1, page 109, foot note. Original description.

1879. *Pemphigus ulmifusus,* Thomas:—Rept. Ent. Ill. VIII, (Thomas III) page 153. Brief remarks.

1887. *Pemphigus ulmifusus,* Oestlund:—Aph. of Minn., page 24. Listed for United States.

1890. *Pemphigus ulmifusus,* Packard:—Forest Insects, page 283. List of insects injurious to elm.

1901. *Pemphigus ulmifusus,* Hunter:—Aph. of N. A., page 79. Bibliography.

1902. *Pemphigus ulmifusus,* Cook:—Galls and Insects Producing Them. Ohio Nat. Vol. II, No. 7, p. 265 and Fig. 14, a. b. Discussion of structure of gall.

1903. *Pemphigus ulmifusus,* Cook:—Galls and Insects Producing Them. Ohio Nat. Vol. III, No. 7, p. 425 and Fig. 49, a. b. Discussion of structure of gall.

1904. *Schizoneura* n. sp.:—Sanborn. Kansas Aphididae. pp. 28, 29 and Plate VI, fig. 41, 41a. First real description of this species. Also a description of the gall by Mr. Burrows. This species described and figured as *Schizoneura* from a specimen having M forked as is not unfrequent with this species.

1905. *Pemphigus ulmifusus,* Cook:—The Insect Galls of Indiana. (From 29th Ann. Rept. of the Dept. of Geol. and Nat. Resources of Indiana. 1904, pp. 801-867) p. 849. Bibliography in part.

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*A reference to the grape-vine filbert gall, *Vitis coryloides.*

† *i. e. Pemphigus vagabundus.*

1905. *Pemphigus ulmifusus.* Washburn 10th Ann. Rept. of the State Ent. (Washburn 4th) p. V. Fig. 2. Photograph of galls on leaf.

1908. *Pemphigus ulmifusus,* Jackson. A Synopsis of the Genus Pemphigus. Proceedings of the Col. Hort. Soc., p. 204. Bibliography. Brief description.

1909. *Pemphigus ulmifusus,* Gillette Jour. Ec. Ent. Oct. Fig. 10, antenna.

SCHIZONEURA AMERICANA

Since the excellent account of Riley's so little work has been done with this species that probably a total quotation of the original publication will be more valuable in this paper than anything else which is at present available. It is, therefore, given entire:

"SCHIZONEURA AMERICANA n. sp.

"(Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf, but, according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves).

BIOLOGICAL.

"There is a good deal of irregularity in the time of appearance of the different generations, but the general history of this species, as I have observed it for several years, is herewith given. There is much greater difficulty in fully tracing the life-history of one of these small creatures than might be supposed. They languish in confinement and ill bear handling. To trace their growth and movements in a state of nature requires vigilance and perseverance, and a great deal of time; and I have been fortunate, in my studies of this and the next species, in securing the patient aid of Miss M. E. Murtfeldt of Kirkwood, Mo., a lady to whom I have already had repeated occasion to express my indebtedness.

"If, during the winter, we carefully examine the cracks and crevices of an American or White Elm that was badly infested with this leaf-curling species the previous summer, we shall be pretty sure to find its impregnated egg—a minute, dull-yellowish, ovoid object, about 0.5 mm. long (Fig. 128, *a*), either free or still more or less effectually covered with the parent's dry skin, which faintly shows the insections that characterized the living female. The same spring influences that cause the leaf-buds to swell and open, likewise induce the hatching of this winter egg, and the little creature that issues from it instinctively crawls to the more terminal twigs and branches, and settles upon the first tender leaflet it meets with. It constitutes the stem-mother, or *first genera-*

tion, and, stationing itself on the under surface of the leaf, very soon causes the same to swell and curl by the irritation and punctures of its beak. The curl is usually from the lateral edge, and the more normal form it takes is shown at Fig. 128, *c*. It is, however, very irregular, and takes on many different forms, according as it is produced by one or several stem-mothers settling on the same leaf, and as it affects a portion of one leaf only or embraces several from the same bud. At first, pale yellowish-red with dark members, the stem-mother increases in size more or less rapidly, depending to some extent on the development of the leaf. Moving about in her curled house, within which she is destined to live and die, this stem-mother goes through her last moult, and attains maturity about the twelfth day from the time of hatching. This period may be lengthened by unfavorable weather, as an indefinite period of legarthy, both of plant and insect, may ensue, after hatching, if the temperature be too low. The number of molts I have not definitely ascertained, but from analogy there will be three. Having attained maturity, she commences peopling her pseudo-gall with young at the rate of about one every six or seven hours, according to the temperature, increasing in bulk and prolificacy from day to day, until by the early part of May, in the latitude of Saint Louis, she has attained her fullest development, and soon perishes. She may attain to nearly four millimeters in length, and, with greatly swollen body, be almost as wide (Fig. 128, *b*). Her immediate issue, or the *second generation,* are like her in many respects, but never grow to be quite so large. The individuals of this generation soon accumulate in great numbers around her, and in their turn commence to bring forth young, some remaining within the original curl, others scattering to found new colonies. Their issue, or the *third generation,* show certain marked structural differences from the first (see description), and are destined to become winged.

"During most of the month of May, we may find, where large clusters of leaves are affected, the few more or less exhausted stem-mothers, and these second and third generations in every stage of development. As the lice increase in number, the leaves no longer protect them but present on both sides multitudes of busy atoms—livid, old, and paler young—those with wings and those getting wings—interspersed with white exuviae, cottony secretion, and globules of pearly liquid. At the same time, in single curls of more terminal leaves, we may find the second generation of wingless mothers surrounded by smaller colonies, all of which will become winged. The winged females (Fig. 128, *d*) are short-lived, bringing forth a dozen or more pseudova at average intervals of about half an hour. The glossy pellicle that compresses all the members of their newly-born issue is ruptured very shortly after birth, and is worked off in the course of about ten minutes. These facts are easily ascertained by confining the winged mother, but the exact positions to which the pseudova are naturally carried I have not been able to definitely learn; but we may rest pretty confident that they are consigned both to the leaves and to the twigs. The young lice, forming the *fourth generation,* are very active, running swiftly in all directions. In color, they are at first of a pale and bright red, but soon acquire a

brownish tint. In general appearance, they resemble the young from the stem-mother. The beak is very long, thickened at the end, which always projects beyond the tip of the abdomen, and terminates in a sickle-like point. Experiments made by attaching and confining these young to the trunk of the tree show that they do not flourish thereon, but naturally crawl out to the more tender, terminal leaves, which they immediately begin to curl. They may be found scattered over an infested tree, with their beaks for the most part inserted in the tender leaf-stem or in the midrib on the under side, the leaf in such case already beginning to show the effect of the poisonous puncture. They are, however, able to sustain themselves on the tender bark of twigs alone, and may be found nearly fully-grown, there exposed to view and enveloped in the white cottony matter, which brushes off at the slightest touch. When full-grown, they commence reproducing, and their progeny, under favorable circumstances, becomes exceedingly abundant. The growing points of the tree are affected with larger or smaller colonies, crowding and covering both the surfaces of the leaves, the petioles, and the stem. I have known young Elm trees to be so thoroughly covered with these lice, in the earlier part of June, that not a single leaf was unaffected, and upon giving the tree the slightest jar there would be a perfect shower of the liquid globules excreted by the lice. At this season of the year, when the lice are thus numerous, they may be found during the heat of the day actively crawling over all portions of the tree—a veritable migration, necessitated by the want of sufficient succulent leaves, but evidently premature and destined to be the death of the individuals participating in it, excessive multiplication here, as in all other cases, obliging the destruction of the excess. While the individuals thus wandering are mostly the younger ones, the migrating instinct seems sometimes to possess individuals of all ages, especially where the tree is badly affected; and that they perish is proved by the mass of dead lice which in such a case may be found around the base of a tree. So far as I have been able to learn by confining specimens of the *fifth generation*, which is very similar to the fourth, but with shorter promuscis, the fifth reproduces like the fourth without acquiring wings. The individuals of the *sixth generation*, on the contrary, all acquire wings, the pupa being active, with but a small amount of flocculence, confined to the posterior part of the body. The winged lice of this sixth generation abound during the latter part of June and the early part of July. They resemble those of the third generation, except that they are perhaps on the average somewhat smaller and paler, and less prolific. They instinctively congregate on the bark, and consign to the crevices, and sheltered parts thereof, their young, which, as in the fourth generation, are enveloped in a sort of pellicle. These young also resemble the young of the fourth generation in general form, but have very short and stout beaks. Instead of being active, they are quite sluggish, congregating in clusters in the sheltered portions of the bark, and being essentially bark-feeders. The color soon inclines strongly to salmon or orange, and, after two or three days of sluggish existence, they shed their skin, and become more ac-

tive, penetrating more deeply into the interstices of the bark, and huddling together in groups of various sizes. They are now of a pale buff, or, more correctly, salmon color, the surface at first smooth and polished, but becoming in some instances slightly pulverulent. Simulating closely the color of the bark, and being quite small, they are not easily detected, unless in great numbers. A careful examination shows that they have entirely lost the beak, and that they consist of both males and females, the females being the larger, and the males showing the genital characters given in the description. They live grouped together for several days with little motion, the female (Fig. 128, *e*) increasing in size by the enlargement of the single egg contained in her body. Both soon perish, leaving among their shrivelled bodies the shining, reddish-brown winter egg, either partially or entirely covered by the parent's skin.

"On the 16th of June, 1877, I met with an isolated tree at Malvern, Iowa, belonging to Mr. H. K. Follett, which had been very badly infested with this species. The winged individuals crowded the trunk, and had perished in such quantities around the base of the tree as to lie in a matted mass three or four inches thick, being greedily devoured by their numerous enemies. One could not break off the smallest piece of the bark without finding the exposed interstices crowded with the salmon-colored sexual individuals.

"Among the more prominent of the natural enemies of this species, I have noticed, of Coleoptera, *Coccinella 9-notata, Coccinella sanguinea* (*munda*) Say, *Hippodamia convergens,* and several species of *Scymnus.* I also found feeding upon them the perfect beetle of *Podabrus modestus,* and the Hemipterous *Cyllocoris scutellatus,* Uhler, and *Capsus linearis,* Beauv. A Lepidopterous inquiline, namely, the larva of *Semasia prunivora,* Walsh is also quite common within the curled leaves, feeding both on the lice and on the substance of the leaf. A large green *Syrphus* larva and several *Chrysopa* larvae also prey upon them.

Descriptive.

"*Schizoneura americana* (Fig. 128).—*Impregnated egg* 0.5 mm. long, gamboge-yellow, inclining to brown in color, with no especial external sculpture.

"*First generation.*—Stem mother: Pale yellowish-red, with black members when first hatched; the red deepening and becoming purplish or livid with age. When mature, averaging 3.5. mm in length, globose or pyriform, with subobsolete honey-tubes and six dorsal rows of darker piliferous and tuberculous spots. Antennae 5-jointed, joint 3 more than equalling 4 and 5 together in length.

"*Second generation.*—Differing in no essential respect from the preceding, except that the individuals do not attain so great a size. Bright brownish-red when born, they soon become livid brown.

"*Third generation.*—Mature, winged female: Alar expanse 5 to 5.6 mm. Body dusky ,the abdomen slightly reddish; legs either dusky or yellowish-red. Antennae as long as head and thorax together, dusky, rarely yellowish, not pilose, but with a few short setous points; 6-jointed

the 1st and 2nd joints slightly bulbous; 3rd either surpassing or equaling in length the 4th, 5th and 6th together, which are subequal; the terminal joint usually the shortest, the apical sub-joint being normal, and in some cases sufficiently constricted to resemble an additional joint; joints 3, 4, and 5 rather distinctly annulated the constrictions being generally quite deep, and producing a moniliform aspect, there being on an average 22 such on joint 3. Tarsi with the basal joint distinctly separated into a lobe, the claws strong, and in length twice the diameter of the tarsus. Wings hyaline: front pair with the veins becoming obsolete at tips; stigma subhyaline, either of a yellowish tinge or somewhat dusky; stigmal vein starting from the middle of the stigma and normally curved; cubital vein obsolete for nearly one-third its length, the furcal forming with it almost a point; the terminal distance between first and second discoidals equal to about five times that between their bases (often rather more); terminal distance between furcal and cubital and second discoidal veins subequal that between stigmal and furcal slightly shorter, that between second and first discoidal one-third greater, and about equal that between stigmal and tip of stigma. Hind wings with the subcostal vein almost straight, there being no curve where it gives off the discoidal veins, which are obsolete at their extreme base and not confluent with it. (The wing venation is very constant. Out of nearly 100 specimens examined, I have found only an unusual shortening of the cubital in two individuals). The larva and pupa in this third generation differ from the winged insect in being more reddish and in having the antennae ringed with less distinct constrictions, in the legs being paler, in the claws being stronger, and in the basal joints of tarsus being more connate with the terminal joint. They have a distinct annulated elevation at each side posteriorly—a sort of pseudo-honeytube. When first born they are of a pale dull yellow, and the antennal joints are more nearly subequal in length.

"*Fourth generation.*—That from the first winged females: Differs from the preceding in the promuscis being much longer, in the antennae having but five joints, the third being somewhat longest and the first the shortest, but all often being of much more nearly equal length, with no annulated constrictions. The color is more decidedly orange. When newly hatched, the thickened end of the promuscis often extends one-half the length of the body beyond anus. The legs are also long and stout, and the basal joint of the tarsus is distinct, but not separated. The capitate hairs are obsolete. It is born with an enveloping pellicle or pseudovum, and though of a bright red with pale legs at first soon becomes brownish, with dark members.

"*Fifth generation.*—The counterpart of the second.

"*Sixth generation.*—Second winged: Resembles the third, but usually rather lighter colored, with the wing-veins, the spinous armature of surfaces, and the constrictions of antennae less strong, and with the third joint of antennae rather less in length than the terminal three together.

"*Seventh generation.*—True sexual individuals: Born within an egg-like pellicle. With stout promuscis reaching to between middle and hind

coxæ; the antennae 5-jointed, with the joints subequal. Bark-feeding. Orange in color. Undergoing one moult and then being at once distinguished from the other forms by the brighter orange-yellow color, the rudimentary mouth, the more simple eyes (composed of three facets), by the shorter, 5-jointed antennae, the joints subequal in length; by the shorter legs, with smaller claws to the tarsi, and more distinct terminal capitate hairs or pulvilli. The skin is transparent, the body filled more or less with fatty globules. The female is nearly pyriform, and averages 0.4 mm. in length. A single egg is visible through the translucent skin, and, according to age, occupies more or less of the whole of the body. The male is narrower and smaller, the penis being bulbous, with a couple of spine-like genital clasps.

"This species is very closely allied to the European *S. ulmi* (Linn.), and until I was able to compare it with actual specimens I was in doubt whether to look upon it as a mere variety or a distinct species. Judging from Kessler's figure and description of the European leaf-curl, and by a figure sent me by Mr. Buckton, it differs from ours, 1st, in bending upward, *i. e.,* the stem-mother settles on the upper instead of the under side of the leaf; 2nd, in having a number of small rounded or verrucose swellings. These differences in their dwellings are strongly presumptive of structural differences in the insects themselves; and the fact that *S. americana* does not attack the European Elms, either in Shaw's Botanical Gardens at Saint Louis, or in the grounds of the Department of Agriculture, points in the same direction. Differences are indeed easily enough made out if we take the more or less imperfect descriptions and figures of *ulmi,** but are less apparent when the actual specimens are compared. The following are the more important differences, least subject to variation, between the winged female of *ulmi* as compared with those of *americana*: *ulmi* is a longer-winged species averaging 7.3 mm. in expanse; the abdomen, wing-veins, and stigma are darker; the terminal distance between 1st and 2nd discoidals slightly greater; the 3d joint of antennae is relatively longer; the annulations are less deep and more numerous (those on 3d joint averaging 30); joints 5 and 6 are smoother, *i. e.,* without annulations, but they are more setous; joint 5 is shorter than 4; the apical, narrowed part of 6th joint is relatively longer and more pointed; the subcostal vein of hind wings is less straight; the cubital vein is often continuous to very near the subcostal, while I have not found any tendency of the kind in *americana,* the tendency being in the opposite direction, or to become shorter ;the 2d discoidal of hind wings shows a tendency to fork; the hooklets on costa of hind wings are 3 in number while in *americana* there are normally four;† the legs are more setous."

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*"Koch's figure (evidently copied by Kessler) is faulty in several respects, and fails to indicate the hook-angle of hind wings, or the corresponding thickening of front wings a fault that is, however, common to most of Koch's figures.

†"These hooklets get so easily broken off that they are not to be relied on; yet the normal number on most of the *Pemphiginae* I have examined

There seems to be but one significant point not entirely settled in Riley's life-cycle account, and that is the natural location of the *fourth generation* (*i. e.,* the progeny of the spring migrants). Without definitely proving it he states that "we may rest pretty confident" that the pseudova of the winged mother are consigned both to the leaves and to the twigs, for he says that this *fourth generation* may be found on the tender leaf-stem or in the midrib on the under side. But of especial interest is his statement, "They are, however, able to sustain themselves on the tender bark of the twigs alone, and may be found nearly full grown, there exposed to view and enveloped in the white cottony matter, which brushes off at the slightest touch."

Although I have no definite proof, it is my belief that *Schizoneura rileyi* as common with us in the tender bark of young elms is the summer form of *americana.* I can find no stable character to separate *rileyi* from *americana* and have for several years believed them to be the same species. Professor Gillette (1909) states that he "inclines to believe the two forms are one species" because he is unable to separate them with any certainty.*

Riley figures the antenna of the second generation with 5 segments and states that the 5th is the counterpart of the 2nd generation. A collection of 5 apterous viviparous forms taken from the elm leaf curl, July 16, 1909, all had antenna 6-jointed. Fig. 154.

Prof. J. M. Aldrich (1901) gives a very important record of the spring and return migration of *americana:*

"Some of the specimens in the leaves develop wings and fly to new locations during the early part of the summer; and about midsummer all the rest do the same, so the old leaf-nests are deserted. Where they go has not yet been found out. There is a closely related form in Europe that migrates to grass and it is probable that ours do the same.

"In September the return migration takes place. Last year it was a very conspicuous affair in Moscow, as all the trees, of whatever kind were surrounded by a hovering swarm of delicate, winged lice. These return migrants do not eat anything, and after a few days their dead bodies were very abundant on the trunks of many trees, filling the

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is 3, while in *Hormaphis* there are but 2. The fact that in *Sc. americana* there are 4 is therefore interesting, and of some value in this connection."

*Notice, also, the comment on *Schizoneura fodiens* Buckton, p. 233 of this bulletin.

crevices of the bark. All that they do on their return is to bring forth a new brood of little lice. These young develop into the true egg-laying form, male and female. They are wingless and mouthless very small when grown, bright orange in color, and seem to have no object in life except the deposition of eggs, since they can not eat or fly. The eggs are placed in the deepest crevices of the bark, especially those that are tangential to the tree, and are not easy to find. The small lice perish after depositing eggs leaving only the latter to survive the winter.

"Last fall the egg-laying brood were abundantly produced on all kinds of trees promiscuously. Their eggs must have been deposited on the same trees, but there is no evidence to show that the young can subsist on any trees but the elm, so it is safe to assume that all on other trees perished.

"The migration of this louse seems not to have been noticed by other entomologists. It was strikingly apparent last year with us."

Sanborn (1904) describes carefully and figures the winged form of *americana* and adds:

"This form was taken June 16, on the elm (*Ulmus americana*). They colonize the ventral side of the leaves, causing them to curl. When numerous they give the leaves a whitish appearance and cause the terminal ones to bunch together, which gives the lice more protection. When the leaves begin to turn yellow and look sickly from the attack of the aphids, the latter are acquiring wings and beginning to migrate. This migration, according to my friend Mr. E. H. Tucker's observation, takes place most conspicuously about twilight, for he says: 'In the twilight of the evening I took several winged specimens. The air had floating in it numerous white insects. After capturing some I noticed that it was a cottony secretion which gave them their white appearance and also sustained them or caused them to be wafted along by the wind'. According to this statement, the flocculent material acts as a sail by which these insects are carried as well as by the aid of their wings."

I have observed the migration from the leaf curl in mid-July at Orono.

In the present paper, the object of which is not taxonomic, this species is treated under the name given it by Riley, although I am of the opinion of Thomas, who commented in regard to this, "it is doubtful whether it should be considered as distinct"* from *ulmi*. Professor Gillette (1909) gives *americana* as synonym of *ulmi* of Europe. Perhaps a brief discussion of Riley's reasons for considering this distinct† may not be without interest. He states that:

1. '*Ulmi* is a longer winged species averaging 7.3 mm. in expanse.' (Absolute size can hardly be held a specific distinc-

†Riley and Monell on Aphididae. p. 9.

*Thomas III Report, page 204. 1879.

tion. Many specimens of *americana* taken July 1, 1909, in Maine attain 7 mm. wing expanse).‡

2. 'With *ulmi* the abdomen, wing veins, and stigma are darker.' (This difference might perhaps be accounted for by the difference between newly molted and aged individuals).

3. 'With *ulmi* the terminal distance between 1st and 2d discoidals is slightly greater.'

4. 'With *ulmi* the 3rd joint of antennæ is relatively longer; the annulations are less deep and more numerous,—those on 3rd joint averaging 30.' (A Maine collection of *americana* of July 1, 1909, have III with a range of from 24-30 annulations. Professor Gillette figures this species with 35 annulations).

5. 'With *ulmi* joints 5 and 6 are smooth, *i. e.*, without annulations, but they are more setous.' (Maine collection of *americana* of July 1, 1909, have V and VI smoother than Riley's figure, VI being indeed with no annulations and V having 2 to 7 and these not completely encircling the antenna).

6. 'With *ulmi* joint 5 is shorter than 4.' (This is also the case with the aforesaid Maine collection of *americana*).

7. 'With *ulmi* the apical, narrowed part of 6th joint is relatively longer and more pointed.'

8. 'With *ulmi* the subcostal vein of hind wings is less straight.'

9. 'With *ulmi* the cubital vein (M) is often continuous to very near the subcostal, while I have not found any tendency of the kind in *americana,* the tendency being in the opposite direction, or to become shorter.' (Maine 1909 material of *americana* has wings very uniformly like fig. 152, (comp. Buckton's figure of *ulmi*), and no wing with M as figured by Riley. "Cubital vein of fore wings obsolete for some distance at base, rarely traceable its whole length." O. W. Oestlund, Aphid. Minn. p. 27, 1887).

10. 'With *ulmi* the 2nd discoidal of hind wings shows a tendency to fork.' ("Freak" venation is not uncommon with aphids).

11. 'With *ulmi* the hooklets on costa of hind wings are 3 in number, while in *americana* there are normally 4.' ("Those

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*For measurements of *americana* see comparison with *rileyi* footnote page —— of this bulletin.

British insects which I have examined show also four hooklets on the lower wings." Buckton. British Aphides. Vol. III, p. 100, foot note to a reference to Riley's statement in regard to *ulmi*).

12. 'With *ulmi* the legs are more setous.'

It would seem that the relative differences noted by Riley may be locational or seasonal,—at least not specific. At any rate the 1909 Maine *americana* correspond more closely to Riley's 1879 characterization of *ulmi* (of Europe) than they do to his description and figures of *americana*.

As to the differences in the leaf-curl or pseudo-gall of *ulmi* and *americana* a mistake has been recorded. Riley* says: "Judging from Kessler's figure and description of the European leaf-curl, and by a figure sent me by Mr. Buckton, it differs from ours, first, in bending upward, *i. e.*, the stem-mother settles on the upper instead of the under side of the leaf; second, in having a number of small, rounded, or verrucose swellings."

Kessler's figure is misleading because it is inverted, that is, the ventral surface of the leaf is placed uppermost on the plate. But his description of the gall in the same publication (1878) to which Riley evidently had not access, states explicitly enough that the insects are on the under side of the leaf.†

Buckton's figure of *ulmi* leaf-curl, Vol. III, Plate CVIII, is misleading for the same reason,—it is inverted on the plate, which places the ventral side of the leaf uppermost. That Riley was mistaken nevertheless in thinking that the *ulmi* leaf-curl differed from that of *americana* in this respect is abundantly shown by the following citations.

Koch, 1857, p. 264, says of *ulmi*, "die eine seite des Blattes sich unterwärts zusammenrollt."

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*Riley and Monell on Aphididae, page 8.

†"*Schizoneura ulmi* afficirt den grössten Theil der einen Hälfte des jungen Blattes und zwar an der Unterseite der Zeit, wann dasselbe aus der Knospe hervorwächst. Dadurch entsteht auch hier intercalares Wachsthum in der Art, dass die Zellenbildung an und längs der Hauptrippe, aber in die Regel nicht bis an die Spitze und an den Grund des Blattes, am energischsten vor sich geht, wodurch der schon ausgebildete Rand sich nach der Unterseite des Blattes umbiegt und diese Blatthälfte mit der Zeit eine gelblich grüne, wulstige Rolle bildet (Fig. 5)."

Buckton, evidently with Riley's statement in mind but not clearly, states, Vol. III, p. 100:—"Prof. Riley describes an elm Aphis under the name of *Schizoneura americana,* and which he thinks is distinct from *Schizoneura ulmi* of Europe. One peculiarity of this insect is, that it rolls the leaves from below upwards, from which I gather that it feeds on the upper surfaces instead of on the lower, as with us." Buckton describes the leaf curl of *ulmi* (p. 98) as "the leaf curl from above downwards into a roll of a sickly yellow colour."

Kerner, Nat. Hist. of Plants, Vol. II, p. 533, figures *ulmi* leaf curl with the edge rolled under as with *americana.*

The beautiful photograph of several leaves curled by *ulmi* (which would portray leaf-curl of *americana* perfectly) in British Vegetable Galls by Edward T. Connold, 1902, is in accord with his description of the gall of this species, which reads in part (p. 246), "The affected half of the blade of the leaf curls downwards and under, forming an uneven but gracefully shaped roll." He states also: "Elm leaves may occasionally be found where the blade has rolled upwards and along the upper surface. They appear to be the work of the same species." This last accords with Buckton (Vol. III, p. 103): "I have occasionally plucked leaves of the elm rolled *from below upwards,* but I could not discover any unusual specific distinctions in the insects inhabiting them."

Schizoneura fodiens Buckton, the currant root louse, has been recorded as the underground form of *Schizoneura ulmi** for Europe and this point should prove suggestive for further experimental observations with *Schizoneura americana.*

*1896. N. Cholodkovsky. *Zool. Anz.* No. 520, pages 508-513.
1897. N. Cholodkovsky. *Zool. Anz.* No. 530.
1907. J. Barsacq. *Le Jardin.* Vol. XXI., No. 498, p. 348, Nov. 20.
1909. F. V. Theobald. *Insect Pests of Fruit.* pp. 221-222.
1909. Albert Tullgren. *Aphidologische Studien,* p. 169.

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1879. *Schizoneura americana* Riley. Bul. U. S. Geol. and Geograph. Survey. Vol. V, No. 1, pp. 4-9 and Plate I. Fig. 2. Original description and fullest account yet given.

1879. *Schizoneura americana,* Thomas. (III) Report of the State Entomologist Ill. VIII, p. 202. Quotes Riley's description of the seven generations. Fig. 44 after Riley. Thomas concludes (p. 204): "This as admitted by Prof. Riley is very closely allied to *Schizoneura ulmi* Linn. and it is doubtful whether it should be considered as distinct."

1879. *Schizoneura ulmi* Linn., Thomas (III) Rept. of the State Ent. Ill. VIII, p. 140.

(1885. *Schizoneura americana,* Lintner. New Eng. Homestead, 4 July,) 1885, v. 19, p. 269.

1890. *Schizoneura americana,* Packard. Fifth Rept. U. S. Entom. Com. p. 279. Extract from Riley Bul. U. S. Geol. and Geograph. Survey, Vol. V, No. 1.

1889. (1890.) *Schizoneura americana,* Perkins. Third Ann. Report Vt. Agric. Exp. Sta. pp. 160-162. Adapted from Riley. Bul. U. S. Geol. & Geograph. Survey, Vol. V., No. 1. Fig. 18 (after Riley).

(1890. *Schizoneura americana,* Perkins. Eleventh Rept. Vt. St. Board of Agriculture.)

1895. *Schizoneura americana,* Piper. Bul. No. 17 Wash. Agr. Exp. Sta. p. 48. Brief account.

1897. *Schizoneura americana,* Gillette Bul. Div. Ent. U. S. Dept. Agric. 9 (n. s.) : 78-79. Description of work.

1898. *Schizoneura americana,* Gillette Bul. A. E. S. Colo. *47*: 35-36. Account of work. Economic treatment. Fig. 32 photo of work.

1899. (1900.) *Schizoneura americana,* Harvey. Bul. Me. Agr. Exp. Sta. No. 61. *Indem.* Ann. Rept. of Me. Agr. Exp. Sta. for 1900, p. 32. Mentioned as abundant. Photograph of leaf curl.

1900. *Schizoneura americana,* Lugger. Bul. No. 69. Minn. Agr. Exp. Sta. Id. 6th Ann. Rept. St. Ent. of the St. Exp. Sta. Univ. of Minn. pp. 168, 169. Fig. 148 after Riley.

1901. *Schizoneura americana,* Aldrich. Idaho Agric. Exp. Sta. Feby. Bul. 26, pp. 20-22. Records summer and fall (return) migration and describes true sexes. Suggests that alternate host plant may be grass.

1901. *Schizoneura americana,* Cockerell. Bul. 38. Arizona Agr. Exp. Sta. p. 265. Mere mention.

1902. *Schizoneura americana,* Weed. Bul. No. 90. N. H. Agr. Exp. Sta. p. 37. Brief account and photo of curled leaf.

1902. *Schizoneura americana,* Cook. Galls and Insects Producing Them. Ohio Naturalist. Vol. II, No. 7, p. 265 and Fig. 12. Discussion of structure of gall.

1903. (1904.) *Schizoneura americana,* Washburn. Bul. No. 77. Minn. Agr. Exp. Sta. Injurious Insects in 1902. Idem. 11th Ann. Rept. State Ent. of Minn.) p. 45. Mere mention.

1904. *Schizoneura americana,* Sanborn. Kansas Aphid. pp. 25-26, Plate VI, fig. 37. Description of winged form and record of migration.

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1905. *Schizoneura americana,* Cook. The Insect Galls of Indiana, p. 851—brief mention with reference. (From 29th Ann. Rept. of the Dept. of Geol. and Nat. Resources of Indiana 1904, pp. 801-867).

1905. *Schizoneura americana,* Felt. N. Y. St. Mus. Memoir *8*: pp. 172, 177-178. Description of leaf curl, and life history adapted from Riley.

1909. *Schizoneura ulmi* (*americana*), Gillette. Journ. Ec. Ent. Oct. Fig. 16. Antenna.

SCHIZONEURA RILEYI

Eriosoma ulmi Riley.

(Found clustered in woolly bunches on trunk and branches of young elms—*Ulmus americana,* causing knotty growth. Fig. 163).

Descriptive.

———*? generation, apterous viviparous form.* Head, antenna, and thorax light brown. Legs light brown with dusky points. Abdomen brown and very flocculent. Antennæ 6-jointed, III, 0.22 mm.; IV, 0.08 mm.; V, 0.09 mm.; VI, 0.1 mm. Total body length 2 mm Color description from live mature specimens examined August 4, 1906. Measurements from balsam mounts.

Habitat,—Closely packed in woolly bunches on trunk and branches of young elm, causing knotty growth of wood. Maine collection numbers,—Aphid 69-05, Aphid 95-06, Aphid 89-08.

———*? generation, winged viviparous form.* Head and eyes black. Antenna* black, 6-jointed, III, 0.4 mm.-0.5 mm.; IV, 0.11 mm.-0.135 mm.; V, 0.13 mm.; VI, 0.09 mm.-0.11 mm. Number of annulations, III, 17-22; IV, 4-6; V, 7-9; VI, 3-4. Prothorax and thorax black. Wing expanse, 6.25 mm.-6.50 mm. Veins slender and light brown. Shape of wings and trend and extent of veins as in *americana* (Fig. 157). Femora dusky at distal part, tibia very pale, tarsus dark. Abdomen dark brown and flocculent. Color description from live speci-

*For comparison the antenna of *Schizoneura americana* of Maine collection 5-09—July 1, 1909, is given: III, 0.4 mm.-0.5 mm.; IV, 0.18 mm.-0.19 mm.; V, 0.15 mm.-0.165 mm.; VI, 0.13 mm.-0.14 mm. Annulations III, 24-30; IV, 8-11; V, 4-7; VI, with irregular ridge at base of spur. Wing expanse 6.5 mm.-7.0 mm.

mens examined August 4, 1906. Measurements from balsam mounts.

Habitat,—Pupæ developing in woolly bunches on trunk and branches of young elm together with apterous viviparous form just described.

Maine collection number, Aphid 95-06.

———*? generation, true sexes.* The minute apterous oviparous females are born with a beak which is lost with the first (and only) molt. They have a 5-jointed antenna. Total length of body 0.8 mm. This form lays but a single egg. The apterous males are but 0.55 mm. long and their bodies are slender. Their antennæ and legs are relatively much longer than those of the female. Antennæ are 5-jointed. Mature male without beak, this being lost at molt. Described from types taken Sept. 23, 1908. (Figs. 161, 162). Maine collection number, 89-08.

The original description of this insect is as follows:

"The Woolly Elm-Tree Louse—*Eriosoma ulmi,* n. sp.

(Homoptera Aphidae.)

"The White Elm is subject to the attacks of a woolly plant louse belonging to the very same genus as the preceding. This insect appears to be quite common in our State as well as in Illinois, for I have known several elm-trees on Van Buren street in the city of Chicago to be killed by it, and every tree of this description, around the court house in St. Louis was more or less affected with it last summer. The lice congregate in clusters on the limbs and the trunks, and cause a knotty unnatural growth of the wood, somewhat similar to the knots produced on the roots of the apple-tree by the other species. They are mostly found sunk in between the crevices formed by these knots, and the punctures of their little beaks cause the sap to exude in the shape of little silvery globules, which may generally be found dispersed among the knots. The down or woolly matter is secreted by them from all parts of the body, but especially from the posterior part of the back. It is of an intense white color, and is secreted in such profusion that it usually covers and hides the lice, and when they are numerous, gives the limbs from a distance the appearance of being covered with snow. They make their appearance during the latter part of May, and by the latter part of June the winged individuals may be found mixed up with the larvae and pupae. I have experimentally found that a washing with a weak solution of cresylic acid soap will kill them instantly, and they are thus easily exterminated. They are also preyed upon unmercifully by the larvae of an undescribed species of Lacewing fly (*Chrysopa eriosoma* of my MS.).

"*Eriosoma ulmi,* N. Sp.—Color dark blue. Length to tip of closed wings, exclusive of antennae, 0.12.* Wings hyaline, three times as

* *i. e.* inch.

long as wide, and more pointed at the ends than in *E. Pyri.* Costal and subcostal veins, and that bounding the stigma behind, robust and black. Discoidal veins together with the 3d forked and stigmal veins, all slender and black, the forked vein being as distinct to its base as are the others, with the fork but 1-3 as long as the vein itself and curved in an opposite direction to the stigmal vein. Antennae 6-jointed and of the same color as the body; joints 1, 2, 4, 5 and 6 of about equal length, joint 3 thrice as long as either. Legs of the same color as body.

The young lice are narrower and usually lighter colored than the mature individuals, varying from flesh or pink to various shades of blue and purple."

Biological and Discussion.

The number of generations of *rileyi* has not been ascertained. The following records of my Maine collections do not throw much light on this subject, but they are perhaps better than nothing.

Aphid 69-05. Sept. 2, 1905. Present in great numbers in woolly clusters along trunk of small elms at Orono. Apterous viviparous form and nymphs. This material was determined by Mr. Pergande as *Schizoneura rileyi* during the winter of 1905-06.

Aphid 95-06. August 4, 1906. Orono. Apterous and alate forms present on trunk of young elm.

Aphid 7-08. June 16, 1908. Woolly mass on trunk of small elms. Winged viviparous forms just developing from pupae.

Aphid 89-08. Sept. 23, 1908. Orono. Apterous viviparous forms in woolly bunches on trunk and branches of young *Ulmus americana*, causing knotty growth. The progeny of these apterous forms were the true sexes,—apterous oviparous females and apterous males. Eggs were plentiful under the bark.

It will be noticed that there are two generations of winged forms, one in June and one in August, and that apterous viviparous forms were present during the same time.

Not enough structural difference is found to separate *rileyi* from *americana*, and I am inclined to consider them the same species. Professor Gillette (1909) has made this same suggestion. Figures are given of antennæ and wings of Maine material of *rileyi* and *americana* (figs. 152, 153, 157; 154, 159; 155, 158), for purposes of comparison. The wings are practically identical. The antennal differences might seem more significant except for the fact that Riley's description of the antenna of *americana** fits in every particular more nearly my fall collection of *rileyi* than it does my spring collection of

*See page —— in this bulletin.

americana. The differences in venation cited by Riley will not hold for Maine material, as M has so far been found to be obsolete at base in both *rileyi* and *americana.* Moreover Professor Oestlund records an occasional complete M for *americana* (1887). However, absolutely no biological evidence has been recorded which would serve to link *rileyi* and *americana* and they should undoubtedly be held separate until careful experimental rearing evidence has definitely settled this point. If *americana* should prove to be a synonym of *rileyi* and *rileyi* should prove to be a synonym of *ulmi* of Europe, we should have a curious reversion of *ulmi* Riley of America to *ulmi* Linn. of Europe.

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1909. *Schizoneura rileyi,* Gillette. Journal Ec. Ent. Oct. Suggests that it may be same species as *Schizoneura ulmi* (*americana*).

EXPLANATION OF PLATES.

Fig. 126. *Tetraneura* (*colophoidea*) *graminis.* Gall collected from *Ulmus americana.* Orono, Maine. July 8, 1909.

Fig. 127. *Tetraneura ulmisacculi.* Galls collected from *Ulmus montana* var. *Camperdown pendula.* Orono, Maine, July 6, 1909.

Fig. 128. "*Schizoneura americana*: c, c, leaf showing curl—nat. size: a, winter egg; b, stem-mother; d, winged female; i, her antennae; j, her tarsus; e, true female, ventral view showing solitary egg; g, her tarsus from beneath; f, anus and genital points of male; h, antennae of 4th generation—all enlarged." After Riley.

Fig. 129. *Colopha ulmicola*: a, leaf showing galls from above and beneath—nat. size; b, impregnated egg surrounded by skin of true female; c, newly born young of 2d generation, ventral view; h, its an-

tennae; d, pupa of same, dorsal view; e, winged female; f, her antennae; g, antennae of stem-mother—all enlarged." After Riley.

Fig. 130. *Colopha ulmicola* (*eragrostides*). Specimen taken on *eragrostis* sp. Squaw Creek, Iowa, 9-9-93, by F. A. Sirrine. Note that abnormal left hand antenna has but 5 joints.

Fig. 131. *Colopha ulmicola.* Stem mother from cockscomb gall on cork elm. Collected at Iowa Agr. Col.,7-4-'93, by F. A. Sirrine.

Fig. 132. *Colopha ulmicola* (*eragrostidis*). Apterous viviparous form from root of *Eragrostis.* 10-8-'92. Collected by F. A. Sirrine.

Fig. 133. *Tetraneura graminis* (*colophoidea*). Apterous form *not* stem-mother from galls. See page 209.

Fig. 134. *Tetraneura graminis.* Specimen collected on *Aira caespitosa* in flocculent down by J. T. Monell, October 11, 1876. St. Louis, Mo.

Fig. 135. *Colopha ulmicola* (*eragrostidis*) antenna. Specimen from *Eragrostis frankii* bred in Lab. Iowa Agr. Col. 9-20-'93, by F. A. Sirrine.

Fig. 136. *Colopha ulmicola,* antenna. Specimen from cockscomb galls on cork elm. Collected Iowa Agr. Col. 7-4-'93 by F. A. Sirrine.

Figs. 137, 138. *Tetraneura graminis.* Wings of migrants collected on bark of *Ulmus americana.* Iowa Agric. College 10-4-'92 by F. A. Sirrine.

Fig. 139. *Tetraneura graminis* (*colophoidea*). From slide labeled "*Tetraneura ulmi* from cockscomb gall on *Ulmus americana.*" Specimen collected at Iowa Agr. Col. 6-27-'93 by F. A. Sirrine.

Fig. 140. *Tetraneura graminis.* Antenna of Fig. 134.

Fig. 141. *Tetraneura graminis,* true female. On bark of *Ulmus americana.* Collected at Iowa Agr. Col. 10-4-'92 by F. A. Sirrine.

Fig. 142. *Tetraneura graminis* (*colophoidea*). From slide labeled "*Tetraneura ulmi.* Stem-mother. From cockscomb gall on *Ulmus americana.*" Collected by F. A. Sirrine, 6-27-'93 at Iowa Agricultural Col.

Figs. 143, 144, 145. *Tetraneura graminis.* Larvae on roots of *Leersia virginica.* Collected by F. A. Sirrine at Iowa Agric. College. 9-30-'92.

Fig. 146. *Pemphigus ulmifusus.* Normal venation. Collected at LeRoy, Ill., by J. J. Davis. Fig. 147. Wings. Hind wing normal. Fore wing with M branched near tip. Collected at LeRoy, Ill., by J. J. Davis. Fig. 148. Antenna of migrant. Collected at LeRoy, Ill., by J. J. Davis. Fig. 149. Antenna of pupa, see page 221. Collected in Minnesota by O. W. Oestlund. Slide 125-98. Fig. 150. Gall collected in Minnesota by O. W. Oestlund.

Fig. 151. *Schizoneura americana.* Leaf curl of thickly infested tree causing a bunching or rosette of the leaves. Orono, July 7, 1909. Fig. 152. Fore wing. Fig. 153. Hind wing on smaller scale. Fig. 154. Six-jointed antenna of apterous viviparous form. July 16, 1909. Fig. 155. Antenna of winged form. Fig. 156. Typical "Leaf curl" caused by this insect.

Fig. 157. *Schizoneura rileyi.* Wings. Fig. 158. Antenna of winged form. Fig. 159. Six-jointed antenna of apterous form. Fig. 160. Six-jointed antenna of pupa. Fig. 161. Male. Fig. 162. Female. Same magnification as male. Fig. 163. Woolly colony on young elm. Sept.

23, 1908. Orono. Apterous viviparous forms which give birth to the true sexes.

Fig. 164. *Tetraneura ulmisacculi.* Migrant from gall. Fig. 165. Antenna of foregoing. (a) one of the common variations of VI showing "run-together" annulations. Fig. 166. Antenna of pupa. (a) showing annulations of mature antenna through the pupal skin. Fig. 167. Stem mother. Fig. 168. Antenna of stem mother.

Fig. 169. *Tetraneura graminis* (*colophoidea*). Migrant from gall. Fig. 170. Antenna. Fig. 170 (a) reverse side of IV showing annulations. Fig. 171. Antenna of pupa. Fig. 172. Stem mother. Fig. 173. Antenna. Fig. 174. Apterous viviparous form *not* stem mother frequently found in gall. (See page 209.) Fig. 175. Antenna of foregoing.

Fig. 176. *Colopha ulmicola.* Antenna. II-VI. Slide (157) lent by J. T. Monell. Specimen collected July 2, 1876. St. Louis. "Type or co-type of the genus *Colopha.*"

Fig. 177. Antenna III-VI of specimen collected June 12, 1909, at Lawrence, Kansas. Specimens given by C. P. Gillette.

Fig. 178. *Colopha ulmicola.* Antenna III-VI from specimen collected at LeRoy, Ill., July 10, 1907. Fig. 178 (a) Antenna V-VI of second specimen in same collection showing variation in annulations common to this species. Slides lent by J. J. Davis.

Fig. 179. *Colopha ulmicola.* Antenna I-IV of stem mother removed from gall. Slide (7-4-93. I. A. C.) lent by F. A. Sirrine. Antennal measurements I, 0.035 mm.; II, 0.04 mm.; III, 0.1 mm.; IV, 0.06 mm.

Fig. 180. *Colopha ulmicola* (*eragrostidis*). Antenna. (I-IV) of apterous viviparous form from root of *Eragrostis.* Slide (10-8-92) lent by F. A. Sirrine. Antennal measurements I, 0.025 mm.; II, 0.025 mm.; III, 0.035 mm.; IV, 0.035 mm.

Fig. 181. *Tetraneura graminis,* antenna I-IV of true female, previous to molt. Slide (10-4-'92) lent by F. A. Sirrine. Fig. 182. Distal tip of leg of true female previous to molt, showing capitate hairs. Slide (10-4-'92) lent by F. A. Sirrine. Fig. 183. Antenna I-V of larva on roots of *Leersia virginica.* Slide (I. A. C. 9-30-'92). Slide lent by F. A. Sirrine.

Fig. 184. *Tetraneura graminis* (*colophoidea*). Normal venation.* 1987 fore wings out of 2000 examined had this venation.

Figs. 185-197. *Tetraneura graminis* (*colophoidea*). Abnormal venation. The 13 wings out of 2000 examined which deviated from the normal. In even these 13 cases the wing on one side was normal.

Note: Figures 164 to 172 were drawn by Miss Charlotte M. King. Photographs were taken by Mr. R. Hammond.

*For Comstock-Needham terminology of Aphid wings the reader is referred to *"Homologies of the Wing Veins of Aphididae, Psyllidae, Aleurodidae and Coccidae."* Annals Entomological Society of America. Vol. II, No. 2.

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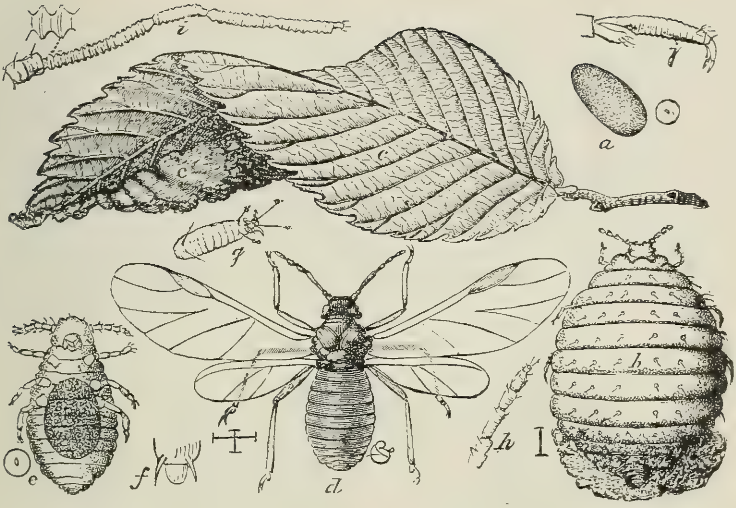

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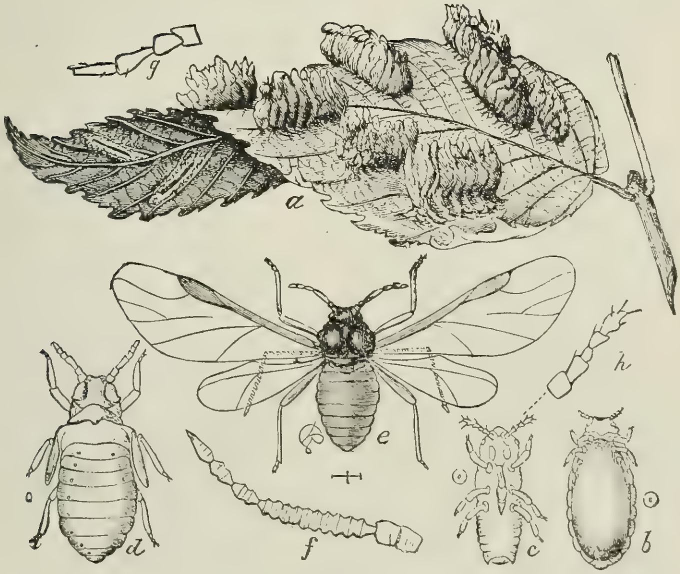

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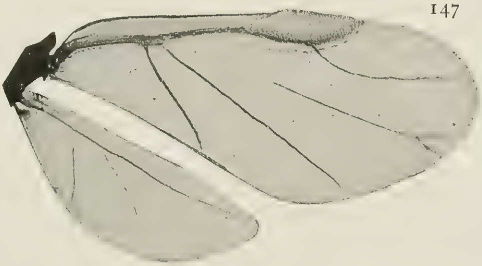

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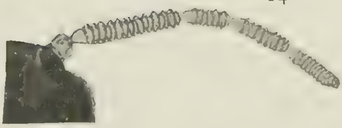

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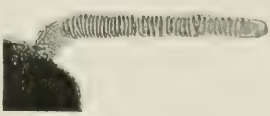

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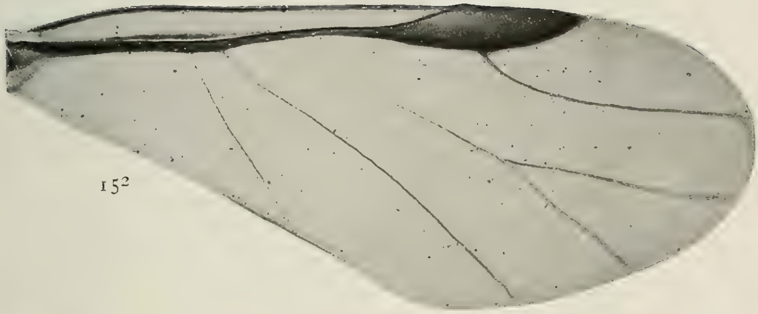

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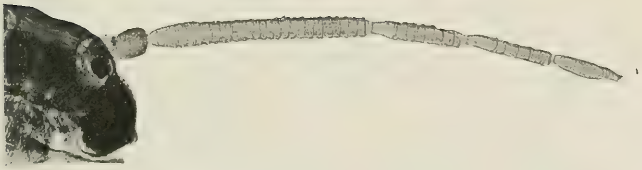

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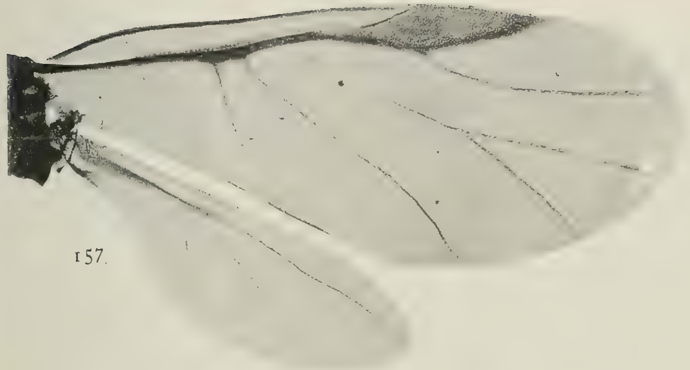

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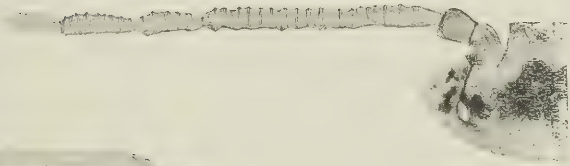

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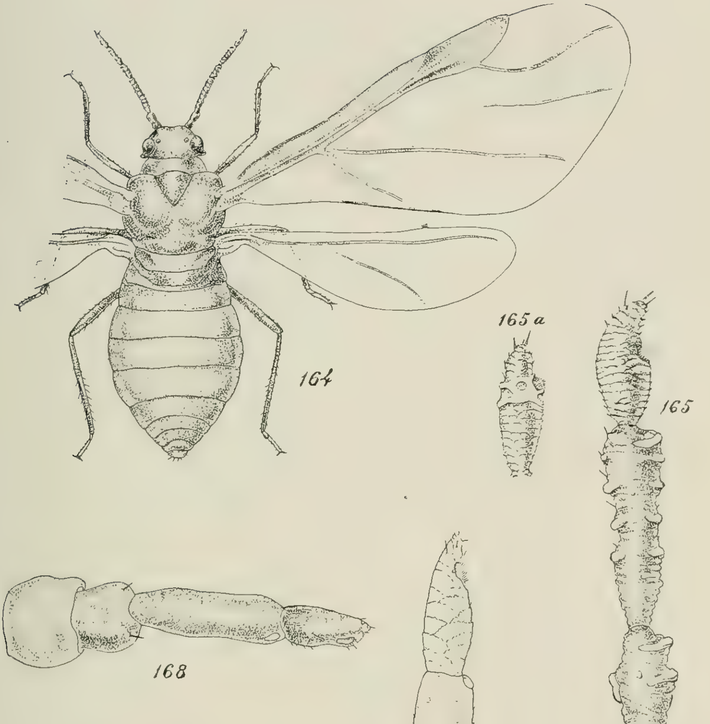
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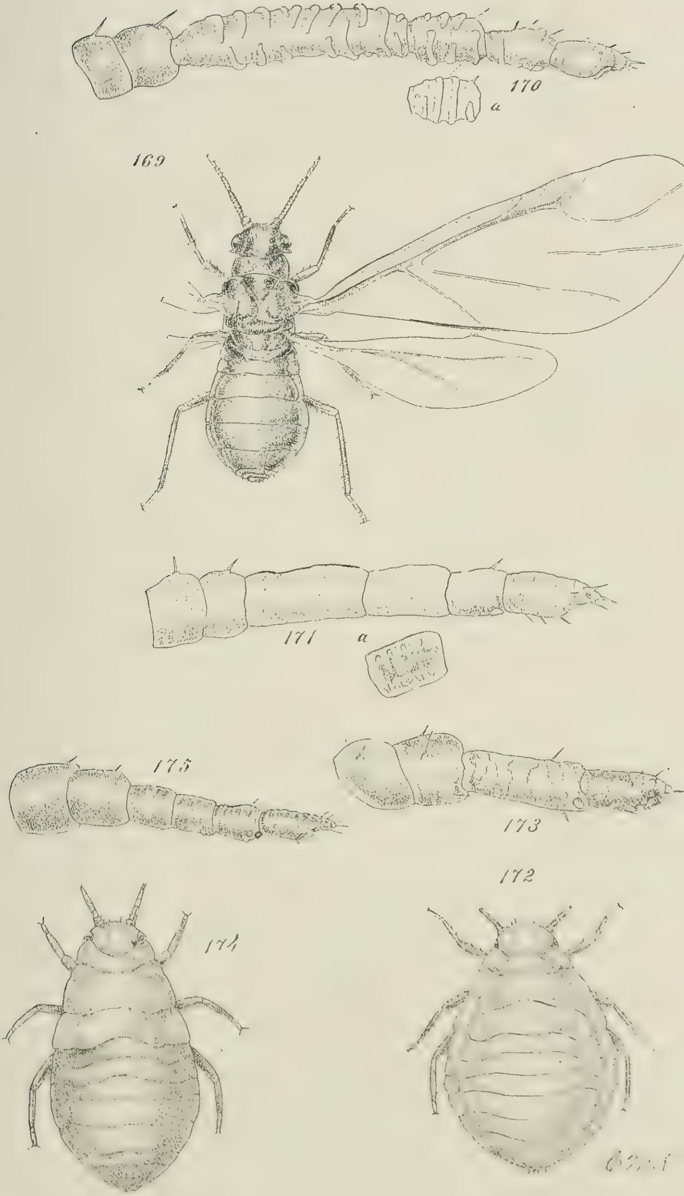
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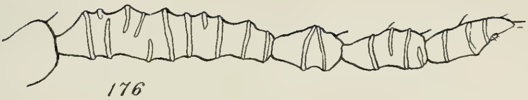

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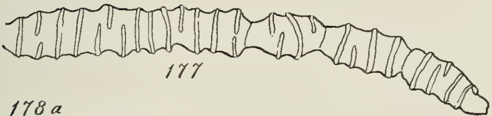

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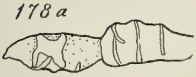

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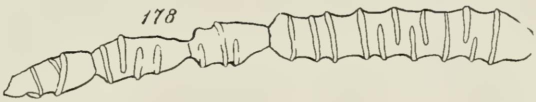

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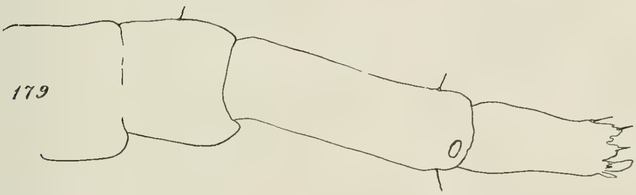

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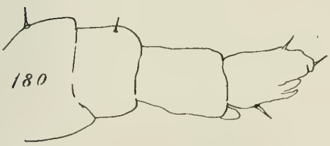

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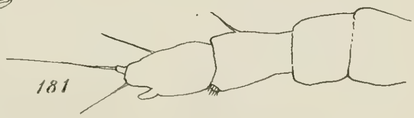

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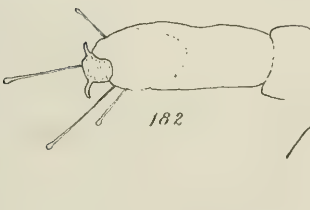

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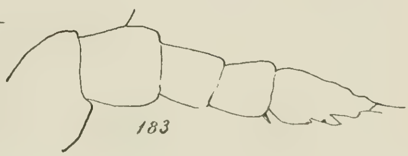

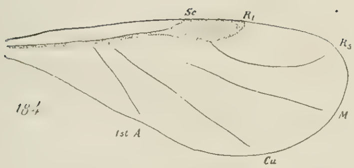

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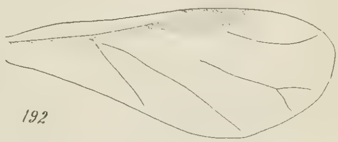
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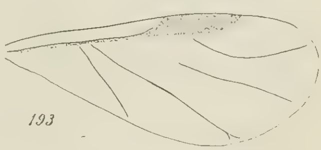
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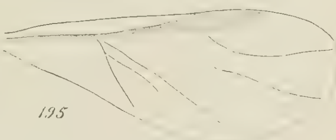
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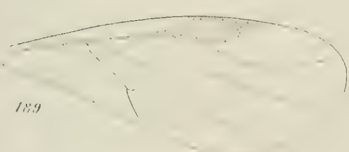
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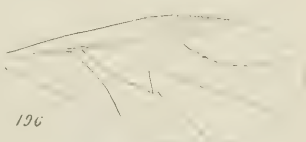
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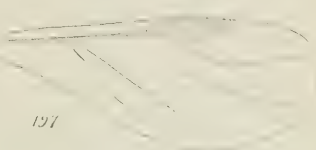
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BULLETIN No. 182

FOUR RARE APHID GENERA FROM MAINE.*

By Edith M. Patch.

It often seems safer to describe American species of aphids as new and run the risk of a synonym than to record them under existing European names and thus incur the possibility of confusion. *S. glyceriae, M. abietinus* and *S. oblongus,* however, are very characteristic, the European descriptions are careful, apparently there is no confusion in European literature in regard to them and each occurs in Maine on the identical genus of food plant upon which it is recorded in Europe. I am venturing, therefore, to present them under their Old World names trusting that they may be able to keep them. *Mastopoda pteridis* though well known on account of its peculiar structure has been so seldom met with that it is appropriately included in this group of rare genera.

SIPHA GLYCERIAE.

1843. *Aphis glyceriae* Koch.
1860. *Sipha glyceriae* Passerini.

This most remarkable aphid excited my curiosity when I first came upon it on account of the fact that many of the aphids were completely submerged in the water on dead blades of grass and apparently in no wise disturbed or inconvenienced by this circumstance, but were to all appearances as comfortable as those above water on live blades.

In structure this species is no less striking than in habits. The body is very flat and appressed to the leaf. The entire body is armed with stout spines. The cornicles are circular openings elevated very slightly above the surface of the abdo-

*Papers from the Maine Agricultural Experiment Station: Entomology No. 44.

men. The beak is stout and short extending to the second coxa. The 5-jointed antenna is short, not reaching the abdomen. The eyes are small but prominent as they protrude conspicuously from the sides of the head. The wings are transparent, narrow and much longer than the body, the venation is practically that of *Macrosiphum*. It is a green species with the abdomen dotted with darker green.

The single large collection made by the writer was taken June 22, 1909, from rush, *Juncus* sp., growing in a marsh pool at Orono. Alate and apterous viviparous forms, nymphs and pupae comprised this collection. Figures 198-205 present photo-micrographs and drawings of this species.

Measurements made from balsam mounts are as follows:—
Apterous viviparous form: Total length 2.25 mm.-2.55 mm. Antenna I, 0.06 mm.; II, 0.075 mm.; III, 0.21 mm.; IV, 0.1 mm.; V (base) 0.11 mm., (spur) 0.11 mm. No sensoria except distal ones of IV and V. Fig. 204.

Winged viviparous form: Total length 1.95 mm. Length of fore wing 2.85 mm. Length of hind wing 1.56 mm. Antenna I, 0.05 mm.; II, 0.05 mm.; III, 0.18 mm.; IV, 0.125 mm.; V (base) 0.1 mm., (Spur) 0.125 mm. III with about 6 large circular sensoria. Distal sensoria on IV and V. The peculiar sensoria on V are well shown in figures 203-203a.

Antenna of pupa much like that of the apterous form. Fig. 205.

MINDARUS ABIETINUS Koch.

The first collection of *Mindarus* in Maine was a single winged specimen taken at Orono June 16, 1905, from leaves of White Pine (*Pinus strobus*). This was kindly determined by Mr. Pergande as *Mindarus* (*Schizoneura*) *pinicola* Thos. the following winter. The next pine collection of this species made by the writer was near Orono June 30, 1909, when a single winged specimen was again taken upon a pine needle. These accord with the description of the winged form by Thomas and also with careful additional notes, measurements, and camera lucida drawings made by Mr. J. J. Davis from the type specimen* and kindly sent me.

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*In the collection of Ill. St. Lab. of Nat. Hist., single winged specimen in balsam labeled "Pine Carb(ondale, Ill.) April 20, 1878."

However on June 11, 1908, a large collection of pale green pupae on the tips of balsam fir was brought to me. Many of these molted during the night and the winged aphids proved to be *Mindarus* and to all appearances *abietinus* Koch described from *Abies* in Europe. On June 14, 1909, a large collection of pupae was made by the writer from balsam fir and winged forms were again secured. These accord with the type specimen of *pinicola* Thomas and it is probable that the pine and the balsam *Mindarus* are the same species, though biological proof is yet lacking. Late in May, 1910, *Mindarus abietinus* occurred in enormous numbers at Orono both on balsam fir and spruce (*Picea canadensis*). The new growth became badly "ruffled" on infested twigs.

Pupa:—Body pale green and very pulverulent. Total length 2 mm. Antenna pale proximal half, dusky distal half, extends to middle of thorax. I, 0.075 mm.; II, 0.06 mm.; III, 0.21 mm.; IV, 0.11 mm.; V, 0.14 mm.; VI, 0.165 mm. Eyes dark. Beak extends to base of 3rd coxae. Wing pads a little dusky. Legs with femora and tibiae pale yellowish, tarsi dusky. Abdomen with fine white silky tufts in lateral rows on each side. Eight large wax gland areas occur in a lateral row on each side of abdomen. Other similar areas occur on the dorsum. These areas are somewhat circular and comprise about 80 or less minute wax pores. Color description from live specimens. Measurements and details from balsam mounts. Maine collection numbers 5-08 and 15-09. Figures 207, 211, 212. *Habits and Habitat.* Curling new tips of balsam fir (*Abies balsamea* Mill) and causing twip tips to look downy. Honey dew excreted in large quantities. June.

Migrant, Alate Viviparous ♀:—Head pale green, eyes dark. Beak extends to 3rd coxa. Antenna extends to abdomen. I, 0.06 mm.; II, 0.065 mm.; III, 0.36 mm.; IV, 0.225 mm.; V, 0.23 mm.; VI, 0.225 mm. III with about 12 large quasi transverse sensoria in an even row, extending nearly the whole length of III. IV, V and VI each with large sensorium at distal portion. The sensoria grouped about the large terminal sensorium of VI are distinct and separate. Spur of VI about one-third the length of the basal portion. IV, V, VI slightly imbricated. Thorax brown dorsal and ventral. Wings pale with dark but delicate veins. Stigma very long, curving to a point near distal

tip of wing. R_s* long and not much curved. M with 2 branches like *Schizoneura* and obsolete at base. Cu and A both slightly curved making the cell between them slightly oval. Costal margin of wing strongly arched. Hind wing broad, venation practically as in *Schizoneura*. Length of wing about *3 mm.* Legs with proximal half pale, distal part dusky, tibiae and tarsi dark. Abdomen pale green, pulverulent. Total length of body about 2.1 mm. Color description from live specimens. Measurements from balsam mounts. Maine collection numbers 5-08, 15-09. Figures 206, 208, 209, 210.

Apterous viviparous ♀. Body pale green, pulverulent. Length 2 mm. Antenna I, 0.07 mm.; II, 0.07 mm.; III, 0.15 mm.; IV, 0.085 mm.; IV, 0.11 mm.; VI, 0.14 mm.

This form was present thickly packed in tips of balsam fir and spruce in May, 1910. They matured about May 25. The honey dew was so abundant that the trees could not be touched without a sticky shower resulting. Maine collection numbers 21-10, 22-10.

Habits and Habitat. Developing in curled tips of *Abies balsamea* Mill and *Picea canadensis* Mill. Migrating from infested *Picea canadensis* twigs about mid-June, immediately after acquiring wings.

Professor O. W. Oestlund has collected this same species near the Pacific Coast.

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1890. *Schizoneura pinicola* Packard. Forest Insects. p. 804. 4-line quotation from Thomas.

1899. *Schizoneura pinicola* Chittenden. Bul. Div. Forestry, U. S. Dept. Agric. *22*: 60. Mere mention.

1899. *Schizoneura pinicola* Britton. 22d Ann. Rept. Conn. Agr. Expt. Sta. for 1898. Brief account of an infestation of pine in Connecticut. Doctor Britton kindly informed me May 13, 1910, that the species concerned in this infestation was not given detailed study.

*For terminology of wing veins, the reader is referred to *Homologies of the Wing Veins of the Aphididae.* Ann. of the Ent. Soc. of America, Vol. II, No. 2.

1901. *Schizoneura pinicola* Hunter. Aphid. of N .A. p. 83. Bibliography.
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1906. *Schizoneura pinicola* Felt. Insects affecting Park and Woodland Trees. *2*: 753. Mere mention.
1909. *Mindarus abietinus,* Patch. Homologies of the Wing Veins of the Aphididae. Ann. of the Ent. Soc. of Am. Vol. II, No. 2. pp. 14, 15. Figs. 18, 19, 20. Discussion of the tracheation and venation of the wings.

SYMDOBIUS OBLONGUS.

On July 17, 1908, this striking species was collected at Orono where it was found to be gregarious upon the branches of birch (*Betula papyifera* Marsh). It occurred largely upon the growth of the previous season, and was difficult to collect on account of its tendency to drop from the branch at the slightest jar. Nymphs, pupae, and apterous and alate viviparous forms were taken in this collection. On August 20, 1908, a second collection of the apterous viviparous form was collected from the branches of birch (*Betula papyifera* Marsh) where it occurred in small colonies. The broad white bands on the dark antennae and the heavy shadowing of the wing veins make this a distinctive species.

Alate viviparous form. Head brown with red eyes. Antenna with I, II, III dark and IV, V, VI with proximal portion white and distal portion dark making a distant and conspicuous banding. I, 0.105 mm.; II, 0.055 mm.; III, 0.7 mm.; IV, 0.45 mm.; V, 0.4 mm.; VI (base) 0.2 mm., (Spur) 0.2 mm. Notice that the spur is very short. III, IV, V and VI are imbricated. About 15 protruding sensoria occur in a row on III, single large sensorium at distal part of V. VI with usual sensorium at base of spur, and separate attendant sensoria. Beak extends to second coxae. Prothorax and thorax brown. Wings with brown veins heavily shadowed. Length of wing 2.95 mm. Legs brown. Abdomen hirsute (spiny), brown with heavy transverse bands of darker brown. Cornicles yellowish white, short, broad, somewhat constricted at the middle, and with flaring opening. Figures 215-219. Color notes from live material. Measurements from balsam mounts. Maine collection number 41-08.

Apterous viviparous form. Head dark brown with red eyes.

Antenna with I, II, III dark, and IV, V, VI with proxmal portion white and distal portion dark. Imbrication and sensoria as in alate form. I, 0.15 mm.; II, 0.10 mm.; III, 0.87 mm.; IV, 0.54 mm.; V, 0.45 mm.; VI (base) 0.22 mm., spur 0.24 mm. Prothorax and thorax brown. Legs brown. Abdomen spiny, brown with darker transverse bands. Cornicles as in alate viviparous form.

The nymphs are brown and thickly beset with spines. Color notes from live material. Measurements from balsam mounts. Maine collection numbers 41-08, 61-08.

1837. *Aphis oblonga* von Heyden, Entomolog. Beiträge in Mus. Senckenberg.
1843. *Aphis oblonga.* Kaltenbach Pflanzenläuse, p. 133, species 101.
1844. *Aphis oblonga.* Ratzeburg. Forstinsekten III, p. 219.
1848. *Aphis oblonga.* Walker. Descriptions of Aphides. Ann. and Mag. Nat. Hist. Ser. 2.
1854-1857. *Callipterus oblongus.* Koch Pflanzenläuse, p. 219. Figs. 292, 293, 294.
1894. *Symdobius oblongus* Mordwilko. Rab. Lab. Zool. Kab. Varch. Univ. (K. Faune Anat. sem. Aphid) p. 54.
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MASTOPODA PTERIDIS Oestlund.

Since this curious species was recorded in 1886 from Minnesota, no account of a second collection has been published. It is interesting in this connection to include a brief description of the apterous form which the writer collected from brake fern near Orono, August 6, 1906. This was kindly determined for me by Professor Oestlund.

Apterous viviparous form: Head and thorax yellowish white, eyes dark. Antenna about the length of body with I, II and proximal half of III white, rest dark. Antenna 5-jointed (6 if spur is counted as distinct joint as in original description). I, 0.1 mm.; II, 0.07 mm.; III, 0.55 mm.; IV, 0.25 mm.; V, (base) 0.10 mm. (spur) 0.65 mm. III without sensoria. IV with single large sensorium at distal end. V with usual sensorium at base of spur. III, IV, V imbricated. The legs are the most characteristic part of this species, the tarsi being atrophied. Abdomen is yellowish white with dark scrawls and tracings. At base of cornicle is a round bright orange spot

which may be absent but is apparently characteristic as it is usually found both in the mature apterous form and in the young nymphs. Cornicles long (0.45 mm.) cylindrical and dark brown. Total length of body 1.65 mm. Color description from living material. Measurements from balsam mounts. Maine collection number 98-06. Figures 213, 214.

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1887. *Mastopoda pteridis,* Oestlund. Aphid. of Minn. p. 49. Description and brief account.

1898. *Mastopoda pteridis,* Packard. Textbook of Ent. pp. 103, 104. Fig. 114. Figures the leg.

1910. Wilson. Pro. Ent. Soc. Wash. Vol. *12,* p. 28. *Mastopoda pteridis,* Oestlund, is by error considered a synonym of *Aphis pteris-aquilinoides,* Raf.*

Explanation of Plates.

Figures 203-207 were drawn by Miss Charlotte M. King. The photomicrographs were taken by Mr. Royden L. Hammond.

Figs. 198-205. *Sipha glyceriae.* 198, Winged viviparous form; 199, pupa; 200, wings; 201, apterous viviparous form; 202, tip of abdomen of apterous viviparous form giving a good view of the cauda; 203, antenna of winged viviparous form; 204, antenna of apterous viviparous form; 205, antenna of pupa.

Figs. 206-212. *Mindarus abietinus.* 206, Antenna of winged viviparous form; 207, antenna of pupa; 208, wings; 209, tip of abdomen of winged form lateral aspect; 210, tip of abdomen

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*Although it would seem to be impossible on the basis of the original description of *Aphis pteris-aquilinoides* to recognize this species if one should chance to re-discover it, fortunately Rafinesque included one character by which his species can readily be separated from *pteridis* Oestlund for he states that the "appendages" (*i. e.* cornicles) are short in *pteris-aquilinoides.* It is perhaps safe to hazard the guess that even Rafinesque would have noticed the atrophy of the tarsi if he had collected so remarkable a species.

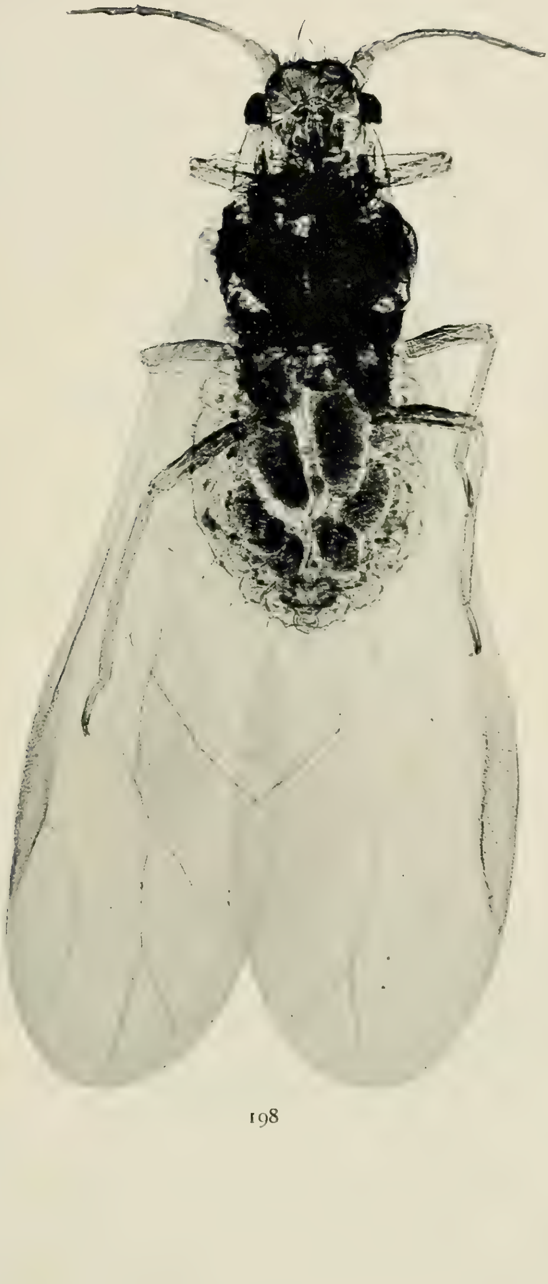
As Rafinesque's papers are not easily accessible, his description of *Aphis pteris-aquilinoides* is quoted entire as follows:

"6. *Aphis Pteris-aquilinoides.* (*P. aquilina Amer. Auct.*) Body pale green, oboval, one line long; eyes brown, antens half a line long; appendages very short." Rafinesque designated the cornicles by the term "appendages."

of winged form dorsal aspect; 211, a single dorsal wax-gland area from pupa, greatly magnified; 212, pupa just before molting, showing the lateral and part of the dorsal wax-gland areas on pupal skin.

Figs. 213-214. *Mastopoda pteridis,* apterous viviparous form and antenna.

Figs. 215-219. *Symdobius oblongus.* 215, wings; 216, caudal tip of abdomen of winged form showing cornicles; 217, antenna showing the alternate banding of light and dark; 218, III, showing sensoria; 219, III, showing sensoria in profile.



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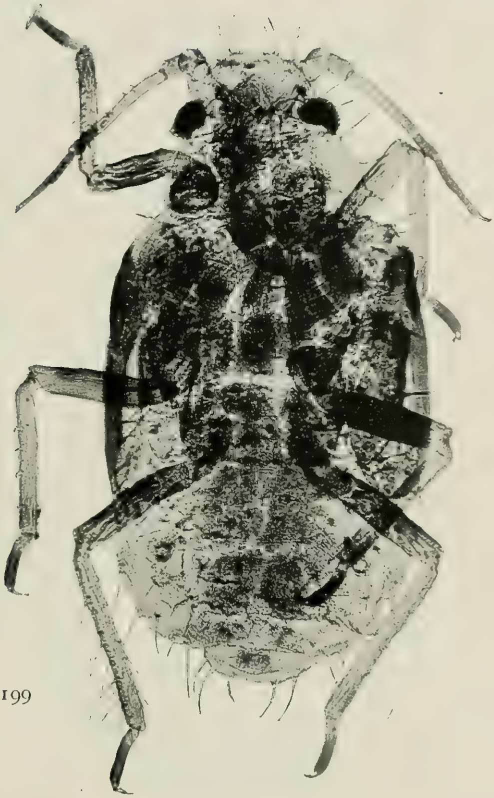

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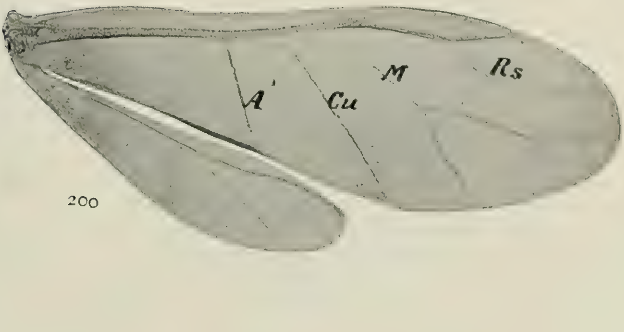

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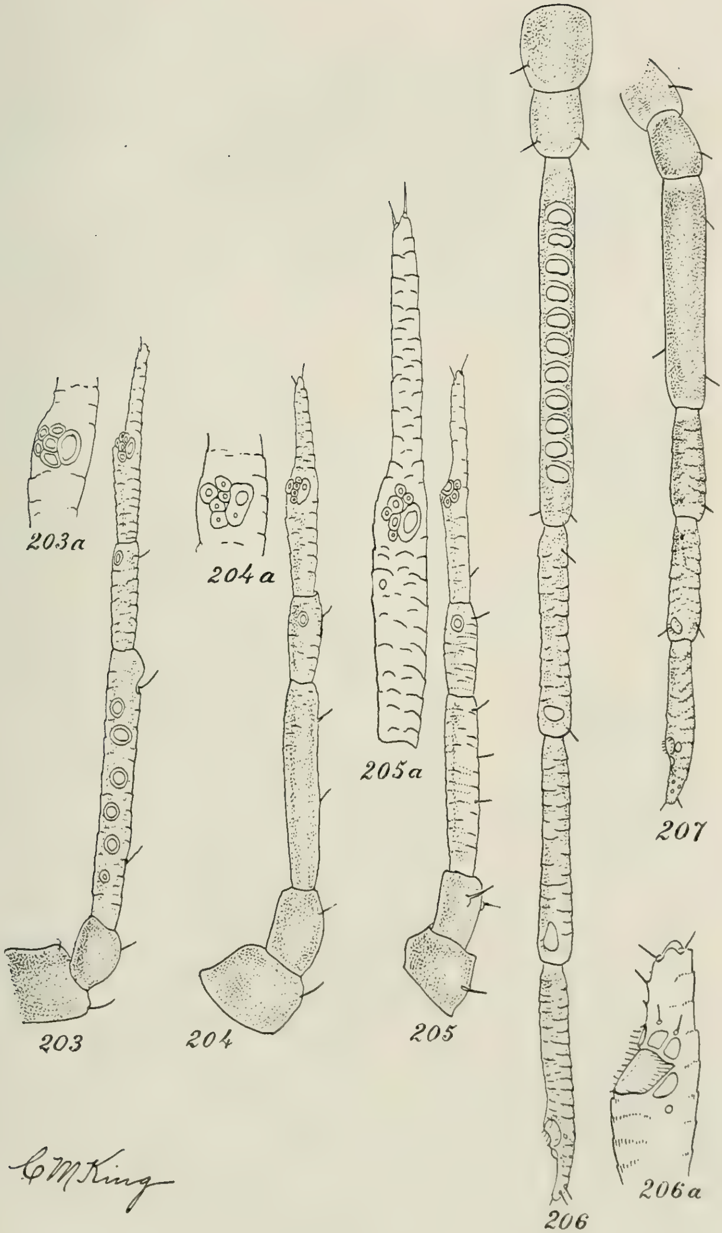
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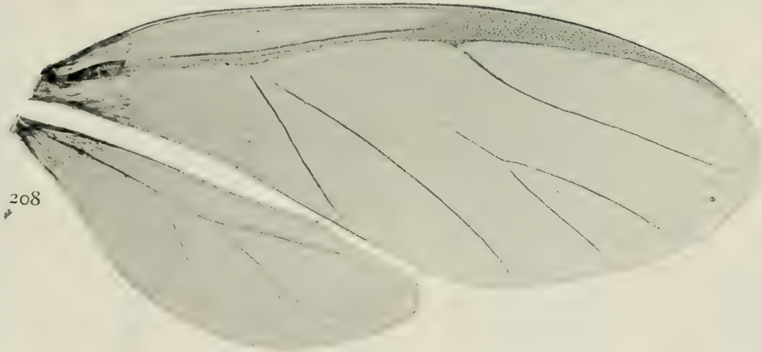
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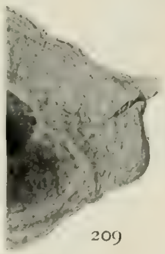
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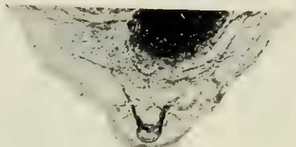
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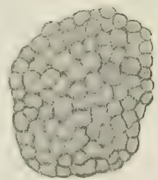
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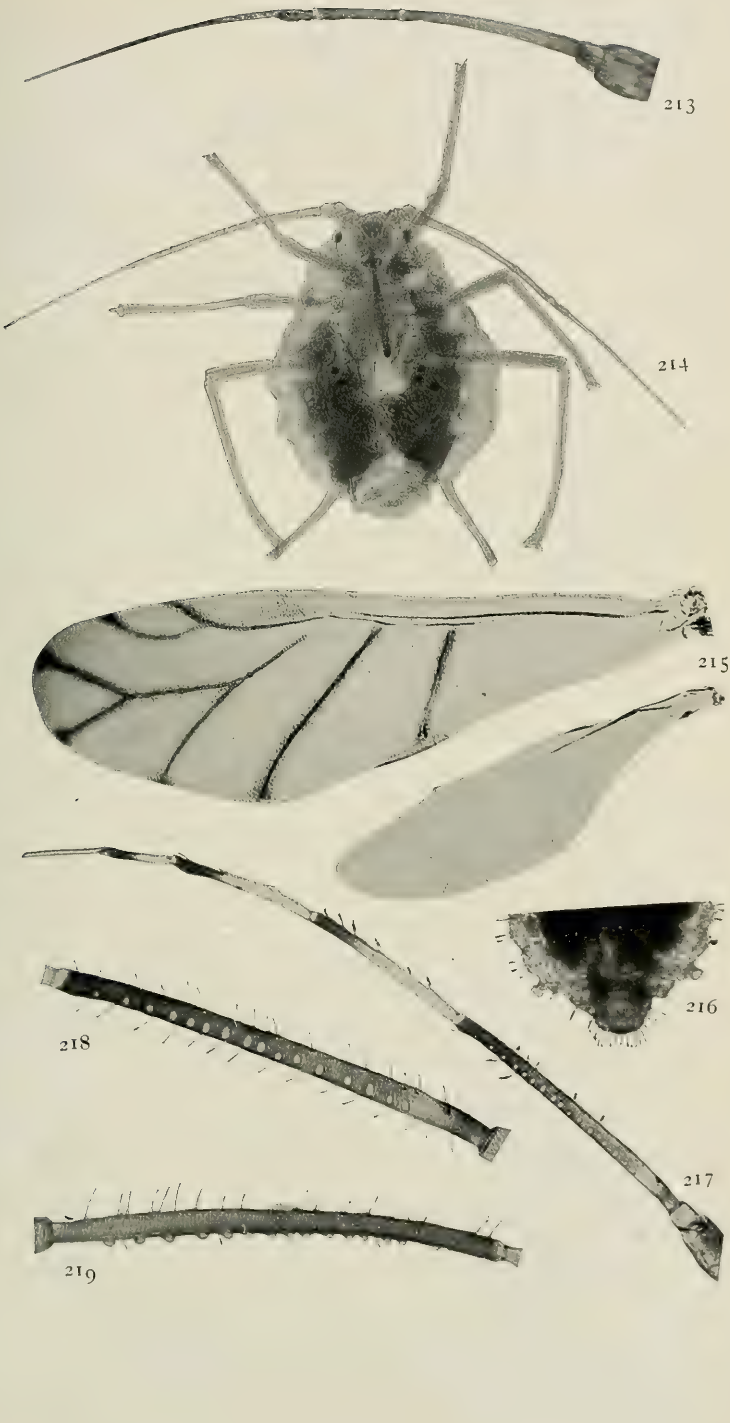
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BULLETIN No. 183

EXPERIMENTS IN BREEDING SWEET CORN.*

By

RAYMOND PEARL AND FRANK M. SURFACE.

INTRODUCTION.

The raising of sweet corn for canning purposes constitutes one of the most important of the specialized agricultural interests of Maine. Throughout the central and southern portion of the State sweet corn is the great "ready money" crop. In this section almost every town has its "corn shop" or "factory" and some places can boast of two or three.

The present magnitude and financial importance of the sweet corn growing and packing industry in the State is probably primarily due to the superior quality of Maine grown corn. "Maine sweet corn" justly holds a high reputation for flavor. To such an extent is this the case that before the advent of the Pure Food Law the labelling of corn grown in other states as "Maine grown" was very common indeed.

Some idea of the amount of sweet corn annually grown and packed within the State may be gained from the following figures, furnished by the National Canners' Association for the 1908 sweet corn pack of the country. While not official, these statistics probably fairly represent the general relations.

State	*Cases*
Iowa	1,085,000
Maryland	1,010,000
Maine	970,000
Ohio	933,000
Illinois	856,000
New York	620,000

* Papers from the Biological Laboratory of the Maine Experiment Station, No. 18.

Wisconsin	343,000
Indiana	301,000
Minnesota	124,000
Tennessee, Oklahoma, Kansas, Missouri, Delaware, Pennsylvania and Michigan together	246,000
All other states	291,000
Total	6,779,000

From these figures it appears that Maine stood third among all the states in the amount of sweet corn packed in 1908. The figures given are for cases of 2 dozen cans each. On this basis the Maine sweet corn pack for the year 1908 amounted, in round numbers, to the enormous total of 23,280,000 cans!

While the sweet corn packing industry has grown to the magnitude indicated in the figures given, it still remains a somewhat hazardous and precarious business, in which both the farmer and the packer are at times compelled to take great risks, and too often to bear heavy losses. The climatic conditions in Maine are the chief source of risk in the business. The growing season to be expected at best is dangerously close to the minimum time necessary to grow good corn. When to this are added the risks arising from the occurrence of late spring and early fall frosts, together with an uncertain distribution of rainfall during the growing season it is evident that there must always be a considerable element of uncertainty as to whether, on the one hand, the farmer who plants sweet corn will get enough out of his crop to pay for seed and fertilizer, and, on the other hand, the packer will be able to produce the number of cans required to fill his contracts.

In view of these considerations it seemed desirable for the Experiment Station to undertake a study of some of the problems connected with the sweet corn industry, with a view to the possibility of being able to help both the farmer and the packer. After looking over the whole field it appeared that the seed problem was one particularly needing attention. The major portion of all the sweet corn grown in Maine is from seed produced outside the state, chiefly in Massachusetts and Connecticut. The seed is for the most part not specially se-

lected or bred to meet the conditions in Maine. Almost the only selection which it undergoes is that of the market. If a lot of sweet corn seed offered for sale is not of the type the packer wants he does not buy it. The packers have great difficulty in procuring sweet corn seed which is satisfactory either to themselves or to the farmers who plant for them. The distribution and entire control of the seed is, and must always continue in general to remain, in the hands of the packers. The farmer sometimes complains bitterly of this, particularly after he has had a lot of poor seed, as too frequently happens. But a moment's consideration must convince one that it would be a suicidal policy for the packer to allow his farmers to plant any kind of seed they pleased. All uniformity of product in the first place, and possibility of economical operation of the canning factory in the second place would be forthwith greatly endangered, and in a short time entirely lost. The farmer must recognize that it is as much to the interest of the packer as to his own that he have good seed. It is the misfortune rather than the fault of the packer that he does not always get it.

The primary aim with which the experiments here discussed were undertaken was to determine whether it was not possible, by the application of simple methods which could be used by any packer or farmer, to improve Maine grown sweet corn and adapt it more closely to the needs imposed by local conditions. It was felt that the broad generalization of plant breeding to the effect that a seed bred in adaptation to local conditions is, on the average, likely to give better results under those conditions than an imported seed is probably true of sweet corn. Subsequent experience has shown that it is. The best sweet corn grown in the State today is the product of Maine grown seed. The second aim of the work was to accumulate scientific data regarding the inheritance of various characters of the maize plant.

The work with sweet corn was begun in the summer of 1907 and has continued since that time. It is believed that the work which has been done has demonstrated the primary thing for which it was started. It has, namely, shown that it is possible by the use of a few simple methods, easily under the control of the packer, to improve in several respects the quality of the average seed corn distributed to the farmers by the packers.

This is all that it was hoped or expected to do. The Station cannot enter upon the commercial breeding of improved sweet corn seed. It can only point out methods by which such breeding may be done by others.

It is the purpose of this bulletin to give a brief account of the general features of the experiments carried on during the past three years in sweet corn breeding. Further discussion of the technically scientific results of this work is reserved for later publication.

Existing and Desired Types of Sweet Corn in Maine.

Practically all of the sweet corn grown in Maine for canning purposes belongs to one or the other of two general types. Representative strains of these two types are grown under different names in different localities. We have accordingly come to pay little attention to the varietal names of sweet corn, in this work. The two main types under which the corn may be grouped are characterized in the following way:

Type I.—A pure white corn, with *small kernels* closely packed on the cob. The number of rows varies from 14 to 22, with an average of 16 to 18. The corn makes a rapid growth and matures relatively early. The stalks, on good land and in a good season, will vary from 5 to 6 feet in height, with an average of from 5 to 5½ feet. The yield of stover is only fairly good, but the yield of ears is usually very good. The ears are shorter than in the case of Type II, and in some strains are well shaped. In other strains the ear, owing to lack of selection probably, tapers very much. Of this type of corn the best is undoubtedly that produced by the so-called Dennett and Ellis strains. These two strains, which, so far as we are able to discover by study both of the growing corn and of the seed, differ very slightly except in name, have for many years been grown for seed in the region around Brownfield, Me. Accounts differ as to the detailed history of these strains, but all agree that this type of sweet corn came into the Brownfield region many years ago (15 to 25?) as a small sample of ears. In recent years there has been no inter-mixture of any other type of sweet corn in this region. On the Dennett and the Ellis farms the same seed has been used year after year without any introduction of "new blood," and without any detasseling to insure

cross fertilization. As a consequence of this practice these strains can only be regarded as very closely inbred. That their yield has not been unfavorably affected is a point of interest. In the propagation of both of these strains on the original farms a very careful *ear* selection is practiced. There has never been any *plant* selection in the case of either of these strains so far as we can learn. Both strains produce a remarkably uniform corn. The breeder who expects to find and isolate wide deviations from type in the case of the pure Ellis or Dennett strains will be disappointed.

Type II—A white corn, frequently showing a faint yellowish tinge, with kernels *larger* and *coarser* than those of Type I, and not so tightly packed on the cob. The number of rows averages lower than in Type I. The ears are longer. The rate of growth and time of maturity vary greatly in different strains. Some are nearly as early as the best of Type I. Others are very late. The stalks are larger and yield more stover than in the case of Type I. The yield of ears, or of cut corn at the factory is usually not so large per unit area of land. The ears are in many strains coarse and ill-shaped, but some strains give ears of high quality. This type of sweet corn is highly popular with the farmer, because of its greater yield of stover. This circumstance has led to its wide adoption by the packer, though from his standpoint it is not so desirable a corn as Type I. In the opinion of the writers the popularity of this coarser type of corn with the grower is not altogether well judged. The farmer, to be sure, gets more fodder from it than from the other type, but he really pays a rather high price for it in decreased yield of ears. This was brought out in a striking manner in connection with some inquiries as to what was considered in different localities a very good to maximum money return per acre of sweet corn. In localities where good strains of Type I corn were the prevailing sort planted it was not difficult to find farmers who, under favorable conditions as to season, etc., had obtained a return of $100 or a little more per acre of corn. In localities where the prevailing kind planted was of Type II we were not able to learn of anyone ever having had a better return than $80 to $85 per acre, the price per pound of cut corn at the factory being the same in both localities. About the same proportionate difference would doubtless be main-

tained with smaller yields. Such a difference represents a rather high price for the fodder from an acre. Typical varieties of corn of this second type are early and medium Crosby, Clark's Medium, etc.

Typical ears of the two types of corn are shown in Fig. 220. These are ears from the 1907 selections(see below). Ear No. 134 is an excellent Dennett ear (Type I). The point in regard to which it is most at fault is the straightness of the rows. It will be noted that they are somewhat curved in this particular ear. Ear No. 381 is a typical early Crosby ear (Type II). The butt is not perfect but the ear as a whole represents this type of sweet corn very well. The reduction of size in photographing is the same for the two ears. They are 5/8 natural size. It is of interest to compare the various characters of these two ears as given quantitatively in tables 1 and 2. Ear 134 has 18 rows, while 381 has but 16. Ear 381 is 2 cm. longer than 134, yet it has but 33 kernels to the average row while 134 has 36. In spite of its larger size ear 381 produced less than 4 grams (equal to about 1/8 of an ounce) more shelled corn than 134.

When the work of the Station with sweet corn was being planned a meeting was arranged between representatives of the Station and of the principal packing interests in the State. The purpose of this meeting was to learn what the packers regarded as an ideal sweet corn for their uses, and in what particulars they felt that the best existing strains needed improvement. As a result of this conference the following points were brought out as of first importance in an ideal sweet corn for canning purposes: 1. Pure white color. 2. Small kernels, giving what is technically termed a fine grained ear. 3. Good flavor and sweetness. 4. Ear of good size, cylindrical rather than tapering in shape, and with butt and tip evenly covered. 5. Rows straight and at least 16 in number. A higher number is desirable in order to get the fineness of kernel. 6. Good yield both of ear corn and of stover. 7. Uniformity of ear type. 8. Early maturity.

The best of the sweet corn grown in the State meets certain of these ideals fairly well. The points in regard to which improvement was regarded by the packers as most needed were (a) earliness, (b) yield, particularly of stover, and (c) con-

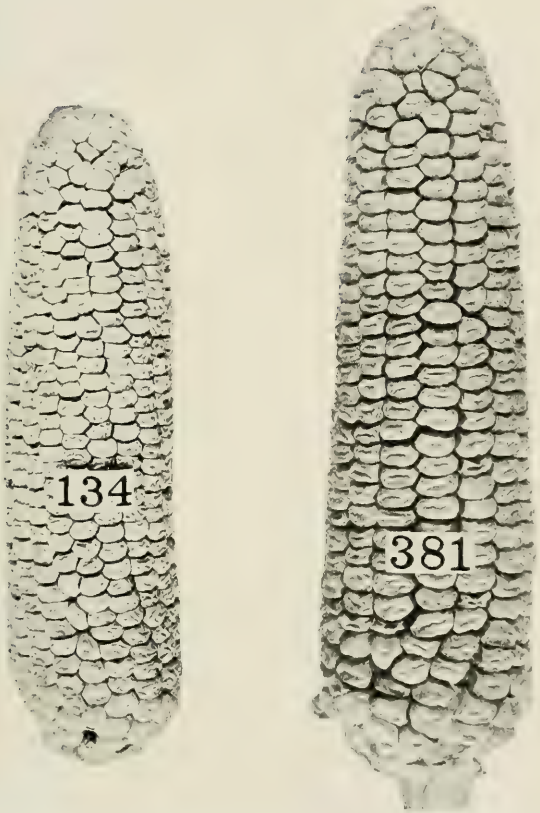


Fig. 220. Representative ears to illustrate the two types of sweet corn (I and II) discussed in the text. Ear 134 is of type I, and ear 381 is of type II. Five-eighths natural size.

formation of ear, especially with reference to shape and covering of tip. The earliness was regarded by all concerned as the most important single point needing improvement.

Accordingly in the summer of 1907 experiments in the improvement of sweet corn in regard to these characters by selection were inaugurated. As already stated it was desired to carry through such selection work in the simplest manner possible, so that in the event of favorable results the same processes could be repeated by any packer or grower. The general plan it was proposed to follow was that of making field selections of plants with reference to the desirable qualities, and then in the following year planting the selected ears on the ear-to-row system which brings the progeny of a single mother ear together in the same row. Advice was sought from some of the leading packers as to localities in which what they regarded as the best corn was grown, so that selection might be started there.

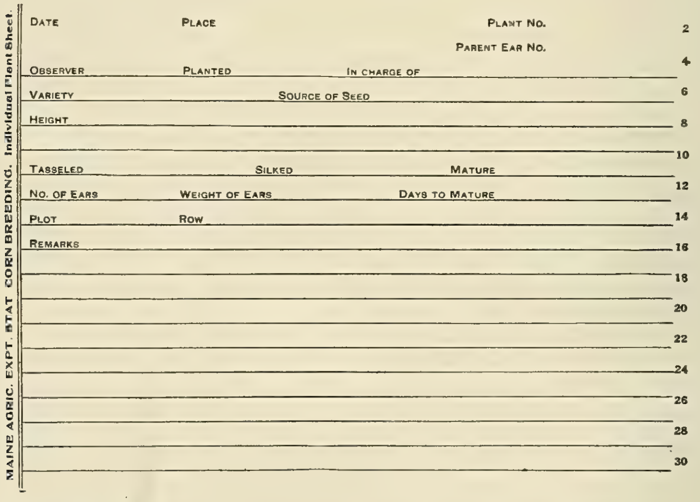
Throughout this work the Station has been greatly indebted to the corn packers of the State for their hearty co-operation, which has made it possible to carry on the investigation in a more advantageous way than would otherwise have been the case. In particular it is desired in this connection to express the gratitude of the Station to the following companies and individuals: The Burnham & Morrill Co., The Portland Packing Co., Fernald, Keene and True Co., The Monmouth Canning Co., H. F. Webb Co., The Saco Valley Canning Co., the United Packers, Mr. F. F. Noyes, Minot Packing Co., and Mr. A. F. York. Also we wish to express our thanks to Mr. J. H. Heath of Farmington, on whose farm all of the sweet corn work except the making of some of the original field selections has been done. Mr. Heath's long experience and skill as a sweet corn grower have been invaluable aids in the work.

Work in 1907.

Late in August 1907 the writers began the field selection of sweet corn. Selections were made from varieties of both Type I and Type II as defined above. The Type I selections were made at Farmington and were from Dennett and Ellis strains. The Type II selections were made at Newport and Dexter and were from early and medium Crosby strains.

In making the field selections earliness was taken as the character of primary importance. This was judged from a variety of characteristics. At the time the first selections were made of the Type I corn, (August 29, 1907) the silks on the earliest plants were dead and thoroughly dried. On many plants in the field, however, the silks were still perfectly green. The stalks and leaves were in all cases still green. Only on the exceptionally early plants had the husks begun to dry out at their ends. All of these points, as well as the condition of the ear itself, were taken into account in judging of the degree of earliness. All plants which appeared especially early, and not absolutely defective in other qualities were marked with a tag bearing a number. In order to make such tagged plants more readily distinguishable in the field there was tied around the top of each stalk a narrow streamer of red cheese cloth.

The number on the tag was the individual plant number by which that plant could at any time afterward be identified in the records. No individual plant number is ever duplicated in the selection work. Notes were taken at the time of the original selection of each plant. These notes were recorded on 5″ x 8″ loose leaf sheets like that shown in facsimile in Fig. 221.


MAINE AGRIC. EXPT. STAT. CORN BREEDING. Individual Plant Sheet.

DATE PLACE PLANT NO. 2

PARENT EAR NO.

OBSERVER PLANTED IN CHARGE OF 4

VARIETY SOURCE OF SEED 6

HEIGHT 8

10

TASSELED SILKED MATURE

NO. OF EARS WEIGHT OF EARS DAYS TO MATURE 12

PLOT ROW 14

REMARKS 16

18

20

22

24

26

28

30

Fig. 221. Facsimile of individual plant record sheet used in corn breeding work.

In addition to the data provided for on the blank, records were taken regarding the number of suckers associated with the plant, the stover qualities of the plant (breadth of leaf, etc.) and any other points thought likely to be of interest subsequently. About 400 individual plants were selected in the manner described during the latter part of August and the first half of September 1907. The general crop of Dennett corn (Type I) at Farmington from which the bulk of the selections of that type were made was hauled to the factory for canning September 12, 1907, and the next few days following. This corn was planted May 18, 1907. The selected plants were allowed to stand and ripen, and were harvested for seed September 26 and 27. But for bad weather the seed could have been harvested a few days earlier. The selected seed of the Crosby varieties (Type II) taken at Newport and Dexter was harvested October 9 and 10, 1907, respectively. The corn at Newport was planted June 4, 1907, and that at Dexter* June 12, 1907. The selected seed ears after harvesting were shipped by express to Orono, and placed on racks in such way that no kernel on any ear was in contact with anything but the air. These racks were placed in the attic of the Station building and the corn was dried at an average temperature of 65° to 75° with some circulation of the air all the time. As will be seen from the germination figures in table 1 below, the seed was satisfactorily cured in this way.

Unfortunately, owing to a misunderstanding, a considerable number of the selected plants in the Dennett plot at Farmington were harvested and lost at the time the general crop was cut for the factory. Through the kindness of Mr. J. H. Heath, on whose farm this corn was raised, it was possible to replace these lost ears by ears which he had himself selected for seed in the same field. His selection, like ours, had been in considerable degree on the basis of earliness. Of course, however, it was not possible in the case of these ears to get any data regarding the original plant on which they grew.

After being thoroughly dried the ears were taken from the racks and subjected to careful study to determine their avail-

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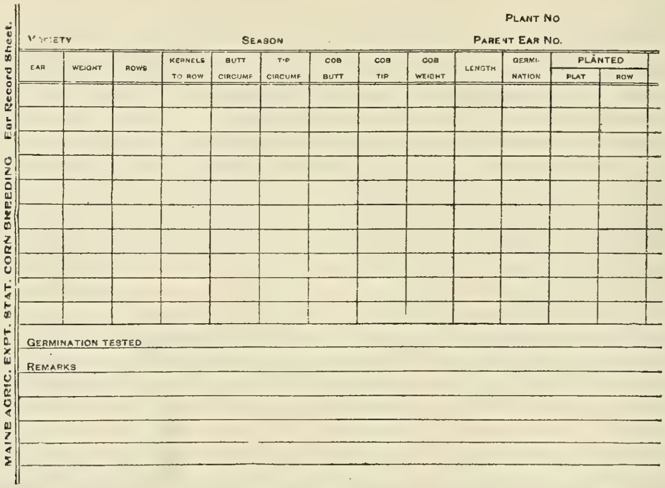
*The field selections at Newport were made on the farm of Mr. Henry S. Thorne: those at Dexter on the farms of Mr. Fred O. Additon, and Mr. John Marsh. To all of these gentlemen we are indebted for their hearty cooperation in this work.

ability for planting. In other words, a second selection was practiced. The first selection had been primarily on the basis of earliness. All the seed harvested (with the exception of the substitute ears already referred to and others taken for particular experimental purposes) was known to have matured earlier than the general average. The second selection was for the purpose of picking out the most desirable of these early ears. In order to put the selection on a quantitative basis, instead of mere general appreciation of quality, the following data were collected for each thoroughly air-dried ear: (a) weight of ear in grams, (b) number of rows, (c) number of kernels in average row, (d) the circumference of the ear one inch from the butt, taken in mm. with a steel tape, (e) the circumference in mm. of the ear one inch from the tip, (f) the circumference in mm. of the cob one inch from the butt, (g) the circumference in mm. of the cob one inch from the tip, (h) the weight of the cob in grams, (i) the length of the ear in cm., and (j) the net weight of shelled corn from the ear. The butts and tips of the ears back a distance of 1 inch from each end were shelled separately from the rest of the ear, and only the kernels from the body of the ear used for seed. The germination of each ear was tested in a Geneva tester, on a random sample of 25 kernels.

The records of these data were made upon loose leaf blanks of the sort shown in facsimile in Fig. 222.


MAINE AGRIC. EXPT. STAT. CORN BREEDING Ear Record Sheet.

PLANT NO

VARIETY SEASON PARENT EAR NO.

EAR	WEIGHT	ROWS	KERNELS TO ROW	BUTT CIRCUMF	TIP CIRCUMF	COB BUTT	COB TIP	COB WEIGHT	LENGTH	GERMINATION	PLANTED PLAT	PLANTED ROW

GERMINATION TESTED

REMARKS

Fig. 222. Facsimile of blank used for the recording of ear characters in sweet corn breeding work.

The data on the ears finally chosen for planting in 1908 of each of the two types are given in tables 1 and 2.

TABLE I.

Data on Ears Selected in 1907 for Planting in 1908. Type I.

Ear No.	Weight in grams.	Rows.	Kernels to row.	Butt circumference in cm.	Tip circumference in cm.	Cob butt circumference in cm.	Cob tip circumference in cm.	Cob weight in grams.	Length in cms.	Net weight of shelled corn in grams.	Germination.	Planted row No.
1.......	102.0	18	36	13.2	10.4	9.7	7.0	21.90	16.4	80.10	100	165
5.......	105.0	16	33	14.8	11.4	9.8	7.2	22.45	16.3	82.55	100	166
6.......	98.0	20	33	14.8	12.6	10.5	8.5	18.00	14.0	80.00	100	174
7.......	84.5	20	38	13.1	11.3	9.2	7.2	17.65	16.5	66.85	100	195
8.......	111.0	18	38	13.9	10.0	9.3	6.3	20.25	16.5	90.75	100	169
9.......	81.0	14	33	13.3	11.3	9.4	7.3	15.85	14.3	65.15	96	149
10.......	106.0	16	36	14.6	11.3	10.0	7.5	22.85	16.7	83.15	100	104
11.......	106.0	18	38	14.8	11.7	9.3	7.5	21.35	16.0	84.65	100	107
12.......	102.0	16	33	13.7	12.5	9.3	7.9	21.50	15.2	80.50	100	121
13.......	80.0	16	30	13.4	10.8	9.4	7.0	14.70	13.0	65.30	100	136
16.......	104.5	20	38	14.3	10.8	9.6	6.9	17.45	14.0	87.05	100	108
17.......	107.0	18	34	13.7	11.7	9.4	7.5	20.30	16.8	86.70	100	173
21.......	109.0	16	38	14.8	11.8	10.2	7.8	21.80	15.8	87.20	100	109
22.......	107.0	16	35	13.7	11.1	10.0	7.0	22.30	17.9	84.70	100	117
23.......	98.5	22	25	15.1	13.5	10.4	8.7	18.60	11.0	79.90	96	124
24.......	87.5	18	35	13.2	12.0	9.8	7.7	20.45	16.0	67.05	96	133
29.......	109.0	18	34	14.8	11.2	10.0	7.3	20.90	15.5	88.10	100	167
33.......	114.0	14	38	14.8	11.9	10.0	7.4	25.40	16.5	88.60	100	168
34.......	98.5	16	27	13.2	11.0	9.3	7.6	18.30	15.3	80.20	96	122
35.......	95.2	14	37	14.1	11.2	10.1	7.4	22.50	16.0	72.70	96	151
36.......	97.0	18	32	13.3	11.1	9.5	7.4	20.00	15.4	77.00	100	126
38.......	78.5	16	34	13.1	11.0	9.4	7.0	16.50	14.0	62.00	100	142
39.......	96.0	16	34	13.6	11.0	9.1	7.5	19.70	15.3	76.30	100	128
40.......	117.7	20	36	15.2	12.0	11.0	7.3	25.40	16.8	92.30	96	112
41.......	104.0	18	32	14.3	11.8	10.3	8.1	20.65	15.5	83.35	92	118
42.......	81.0	20	32	13.5	12.9	9.5	8.3	17.40	15.5	63.60	100	194
45.......	92.0	16	34	13.6	9.5	9.1	6.5	16.60	14.1	75.40	92	175
46.......	93.5	18	34	14.5	12.0	10.0	7.7	25.25	15.2	67.25	84	196
47.......	122.0	18	34	15.2	12.3	10.6	8.0	22.30	17.0	99.70	98	114
48.......	104.0	16	38	14.2	11.7	9.5	7.5	22.00	15.2	82.00	100	102
49.......	88.4	16	34	14.0	11.5	9.6	7.9	17.95	14.2	70.45	100	187
50.......	125.0	18	37	14.7	11.8	10.2	7.8	25.50	16.2	99.50	96	113
51.......	99.5	20	35	13.6	12.1	9.8	8.3	21.95	15.4	77.55	100	161
58.......	96.8	16	32	13.5	12.0	9.7	8.0	22.20	15.6	74.60	96	155
59.......	97.0	20	36	14.4	12.0	10.2	7.6	22.00	16.0	75.00	100	154
60A	76.0	14	34	13.5	10.8	9.3	7.4	14.90	13.6	61.10	100	178
60B	92.8	20	29	14.1	12.9	9.9	8.8	19.10	13.5	73.70	100	176
62.......	98.2	20	35	13.7	10.1	10.0	7.2	20.75	16.5	77.45	100	157
64.......	96.5	18	33	14.2	10.2	10.0	7.0	21.20	17.0	75.30	100	153
67.......	85.0	16	26	13.9	11.3	9.8	7.5	18.00	14.0	67.00	88	182
68.......	114.7	20	37	14.1	12.5	10.2	8.5	22.65	15.7	92.05	100	172
72.......	90.0	16	35	13.5	11.0	9.5	7.7	22.50	16.0	67.50	88	197
78.......	89.0	18	36	13.2	11.0	9.2	7.5	21.10	16.3	67.90	100	192
110.......	90.5	18	35	14.8	10.5	10.5	7.3	19.15	15.0	71.35	100	132
113.......	102.5	16	33	13.9	11.7	10.0	8.1	21.60	15.5	80.90	92	101
115.......	86.5	18	36	13.4	10.6	9.1	7.1	18.50	14.5	68.00	92	193
116.......	85.5	16	31	13.6	11.0	9.7	7.1	16.90	14.4	68.60	100	189
125.......	94.5	16	33	14.0	11.0	9.3	6.8	20.25	16.3	74.25	100	152
127.......	84.0	18	34	12.9	10.5	9.2	7.5	17.50	15.0	66.50	100	198
128.......	72.5	16	30	14.7	11.0	9.2	7.5	15.75	12.5	56.75	96	141
129.......	80.0	18	35	13.5	11.3	9.8	7.1	17.65	13.5	62.35	96	147

TABLE I—Concluded.

Ear No.	Weight in grams.	Rows.	Kernels to row.	Butt circumference in cm.	Tip circumference in cm.	Cob butt circumference in cm.	Cob tip circumference in cm.	Cob weight in grams.	Length in cms.	Net weight of shelled corn in grams.	Germination.	Planted row No.
130.......	87.5	16	35	13.7	11.2	9.4	7.0	18.20	14.5	69.30	100	190
132A.....	101.5	18	35	14.4	10.6	10.6	7.8	22.80	15.5	72.70	100	177
132B.....	84.0	16	40	13.5	11.2	9.5	7.4	25.50	16.5	58.50	100	179
133.......	88.0	16	34	14.2	11.4	10.3	7.5	20.70	15.8	67.30	100	199
134.......	94.6	18	36	12.7	11.2	8.5	7.0	16.80	14.0	77.80	100	160
136.......	89.7	18	32	13.9	11.4	10.0	7.8	20.75	14.8	68.95	100	191
137.......	101.3	20	36	14.0	11.5	10.0	7.7	22.95	16.0	78.35	100	158
138.......	106.8	16	38	14.2	10.8	10.2	7.3	24.50	17.2	82.30	96	103
139.......	79.0	16	30	13.2	11.5	9.1	7.6	17.10	13.5	61.90	100	146
141.......	89.5	16	39	12.7	11.4	8.5	7.0	19.10	16.0	70.40	100	188
143.......	88.5	18	32	14.3	12.4	10.3	8.0	21.65	14.5	66.85	100	100
144.......	82.0	16	33	13.2	10.2	9.2	6.8	17.25	15.3	64.25	100	148
147.......	94.5	16	39	14.0	11.5	9.5	7.3	18.65	14.4	75.85	100	156
148.......	81.5	18	29	13.3	11.7	9.3	7.7	16.00	13.2	65.50	100	134
149.......	82.5	16	35	13.4	11.9	9.3	7.2	17.55	14.5	64.95	100	135
151.......	91.3	16	35	13.5	11.1	9.2	7.2	19.50	15.0	71.80	96	185
154.......	82.5	20	32	13.6	11.6	10.0	7.8	18.10	13.5	64.40	96	137
157.......	113.0	18	39	14.6	10.8	10.0	7.0	24.45	16.6	88.55	96	111
160.......	93.0	18	33	14.1	10.8	10.0	6.7	20.55	13.8	79.20	100	163
162.......	106.5	22	37	14.3	11.5	10.0	7.6	21.50	15.8	85.00	100	106
164.......	81.0	20	37	13.5	10.6	10.0	7.5	21.35	16.8	59.65	100	138
165.......	71.5	16	28	13.8	11.9	9.5	7.5	14.65	12.8	56.85	100	188
167.......	98.3	18	36	14.9	11.9	10.5	7.3	19.70	15.4	78.60	100	162
168.......	75.8	16	34	12.5	9.9	9.0	6.7	17.10	15.5	58.70	100	145
169.......	75.0	16	32	12.8	11.0	9.0	7.3	15.60	14.2	59.40	100	144
170.......	77.0	16	27	13.4	12.7	9.7	8.4	17.50	11.5	59.50	100	139
171.......	90.5	22	34	13.5	11.5	9.0	7.6	18.20	15.2	72.30	100	186
172.......	76.5	18	29	12.3	11.0	9.0	7.8	15.50	14.0	61.00	96	184
173.......	108.0	16	42	13.8	11.7	9.7	7.8	24.40	17.8	83.60	100	105
174.......	85.0	16	38	12.9	10.5	9.1	6.9	19.30	16.5	65.70	100	150
176.......	99.5	20	35	14.5	11.5	10.6	8.0	21.40	15.5	78.10	92	159
177.......	100.0	16	35	13.4	11.5	9.3	7.4	19.60	15.0	80.40	100	164
178.......	77.5	18	36	13.0	11.3	8.8	7.0	14.25	14.0	63.25	100	143
180.......	73.5	16	30	12.6	11.4	8.6	7.4	16.80	12.5	56.70	96	140
187.......	110.5	20	40	14.0	11.2	9.2	7.0	23.15	19.5	87.35	92	116
193.......	87.5	16	30	14.7	11.7	9.3	7.4	15.00	12.0	72.50	100	131
194.......	126.0	20	35	16.1	12.1	11.3	8.0	28.90	16.5	97.10	100	170
198.......	85.0	16	32	13.6	10.7	9.8	7.2	20.10	15.5	64.90	100	183
199.......	88.0	18	37	13.6	10.3	8.5	6.1	13.60	15.0	74.40	84	129
201B	105.0	20	27	16.2	13.2	11.5	8.7	21.60	12.5	83.40	96	120
204.	96.0	16	36	14.4	11.2	9.5	7.0	19.10	16.0	76.90	100	127
206.......	90.8	20	29	14.6	11.5	9.0	6.0	14.45	14.2	76.35	72	181
216.......	98.5	18	38	13.7	10.8	9.4	7.5	24.10	17.0	74.40	100	130
217.......	107.5	20	38	14.4	12.5	9.7	8.0	24.45	17.0	83.05	100	119
218.......	99.0	20	36	14.0	12.4	9.8	6.7	20.50	16.0	78.50	100	123
222.......	141.5	18	36	15.3	11.4	11.0	7.0	29.20	18.0	112.30	100	115
223.......	120.0	16	38	14.4	11.6	9.5	6.4	22.70	16.7	97.30	100	171
225.......	97.0	16	33	13.6	11.4	8.7	7.5	17.70	13.5	79.30	96	125
227.......	110.5	16	40	14.5	11.0	10.0	7.1	21.75	15.0	88.75	100	110
Averages	95.26	17.50	34.32	13.92	11.39	9.68	7.43	20.03	15.22	75.22	97.94	

TABLE 2.

Data on Ears Selected in 1907 for Planting in 1908. Type II.

Ear No.	Weight in grams.	Rows.	Kernels to row.	Butt circumference in cm.	Tip circumference in cm.	Cob butt circumference in cm.	Cob tip circumference in cm.	Cob weight in grams.	Length in cms.	Net weight of shelled corn in grams.	Germination.	Planted row No.
82.......	103.0	14	31	14.2	11.8	9.8	7.8	23.20	15.3	79.80	96	228
83.......	112.0	16	36	14.5	10.9	9.1	6.9	23.20	16.5	88.80	100	217
84.......	100.5	18	32	15.6	12.5	10.7	7.6	23.95	15.0	76.55	100	204
86B.....	95.2	14	33	15.8	12.2	10.5	7.2	19.75	12.5	82.70	80	227
87.......	104.5	18	33	15.4	12.1	10.9	7.5	25.90	16.0	78.60	92	229
88.......	105.0	16	33	14.6	11.3	10.7	7.5	28.45	15.6	76.55	96	203
91.	128.5	18	36	15.4	12.8	10.5	7.6	33.35	17.3	95.15	100	222
93.......	114.0	16	35	14.7	12.0	10.0	7.3	22.90	16.0	91.10	100	219
98.......	101.5	16	33	15.4	12.0	10.5	8.3	26.95	14.5	74.55	100	245
100.......	100.0	16	33	14.6	13.0	9.8	7.9	24.75	15.5	75.25	96	246
105.......	94.7	16	30	15.7	12.1	10.5	7.9	19.15	13.1	75.55	96	231
106.......	121.5	18	34	15.7	12.7	11.0	7.9	28.80	15.7	92.70	100	221
107.......	87.6	16	33	14.6	12.3	9.8	7.5	19.30	14.5	68.30	100	237
231.......	94.7	16	33	13.7	11.3	9.5	7.5	20.75	15.2	73.95	92	241
235.......	95.0	20	33	14.7	13.0	10.2	8.0	23.45	12.3	71.55	96	254
236.......	89.0	18	31	15.0	12.6	10.8	7.5	20.90	13.7	68.10	100	261
241.......	88.5	16	33	14.5	12.0	10.0	7.9	21.85	13.4	66.65	100	264
242.......	88.8	16	33	14.7	12.6	9.5	8.0	20.25	16.6	68.55	96	257
247.......	109.0	16	31	15.7	12.7	11.2	8.5	27.40	15.5	81.60	96	209
257.......	94.0	18	33	15.0	11.9	10.7	8.4	26.15	14.6	67.85	96	238
258A.....	84.3	12	30	13.8	12.5	9.5	7.6	19.70	15.4	64.60	88	239
258B......	82.5	16	26	14.2	13.1	9.6	8.2	17.70	12.8	64.80	96	240
265.......	91.5	16	31	15.5	13.0	11.0	8.3	22.40	12.8	69.10	92	258
274.......	89.5	18	33	14.9	10.6	11 0	6.8	23.40	15.8	66.10	76	265
287......	98.0	18	30	14.9	12.7	10.5	8.0	24.00	14.4	74.00	88	247
292.......	92.5	16	33	14.3	11.5	9.8	7.7	20.80	14.1	71.70	96	253
295.......	99.5	18	33	15.1	11.7	11.0	8.0	26.10	14.8	73.40	100	249
296.......	92.0	14	34	14.0	11.1	9.9	7.0	22.10	18.0	70.90	98	235
303.......	95.5	16	33	14.2	11.1	10.0	7.0	23.80	17.0	71.70	100	252
304.......	103.0	16	33	15.7	13.0	10.0	7.9	24.85	15.3	78.15	100	205
307......	90.0	16	33	14.9	11.8	9.4	7.4	21.55	14.3	68.45	100	262
317.......	102.5	18	33	16.5	13.5	10.6	8.6	26.55	14.5	75.90	100	244
319.......	92.0	20	28	15.4	12.2	10.9	8.1	22.95	14.0	69.05	100	259
329.......	95.5	16	30	14.2	11.9	10.0	7.2	22.90	14.0	72.60	96	250
333.......	117.0	14	37	14.5	11.1	9.4	7.5	27.70	18.1	87.30	92	214
337.......	95.5	20	31	15.2	12.0	11.3	8.3	22.80	14.2	72.70	92	251
338A.....	94.0	16	29	14.1	11.8	9.8	7.5	21.45	14.7	72.55	96	232
338B......	78.8	16	24	13.0	12.0	9.0	7.4	17.25	12.5	61.55	100	233
339.......	88.3	16	30	14.5	12.7	9.8	8.0	19.30	13.9	69.00	88	260
343.......	106.0	14	34	14.6	11.0	10.2	7.2	22.15	17.8	83.85	100	212
346.......	103.5	16	36	15.0	12.3	9.8	7.3	22.45	15.0	80.55	88	208
350.......	103.5	16	33	14.6	11.2	9.7	7.3	22.55	17.2	80 95	100	242
355.......	116.0	16	36	15.3	11.6	10.7	7.4	18.50	16.0	97.50	100	223
357.......	116.5	14	33	15.3	12.9	10.1	8.0	26.55	17.4	89 95	92	218
359.......	94.3	12	35	13.5	11.4	9.0	7.0	19.95	15.0	74.35	96	248
361.......	107.3	18	36	14.9	10.7	9.8	6.2	20.50	16.0	86.80	100	213
364.......	103.0	12	33	13.8	11.5	9.0	7.0	24.00	16.6	89.00	100	224
365.......	119.5	18	35	16.1	13.0	11.1	8.0	31.10	16.5	88.40	92	215
366.......	87.0	16	32	14.0	12.0	8.7	6.8	18.65	15.7	68.35	100	263
370.......	95.0	16	34	14.9	12.6	10.1	8.0	22.70	14.2	72.30	100	234
371.......	92.0	16	30	15.0	12.7	10.3	7.5	21.45	15.3	70.55	100	236

TABLE 2—Concluded.

Ear No.	Weight in grams.	Rows.	Kernels to row.	Butt circumference in cm.	Tip circumference in cm.	Cob butt circumference in cm.	Cob tip circumference in cm.	Cob weight in grams.	Length in cms.	Net weight of shelled corn in grams.	Germination.	Planted row No.
373	104.0	24	34	15.7	12.0	10.1	7.5	23.80	15.0	80.20	100	207
375	94 0	14	36	15.0	11.5	10.0	6.8	17.45	15.5	76.55	96	202
376	103.0	18	37	14.0	11.6	10.0	7.1	26.10	16.0	76.90	96	201
377	94.0	16	29	14.7	12.8	10.0	7.7	22.25	15.2	71.75	92	255
381	106.5	16	33	14.7	11.9	10.7	7.5	24.80	16.0	81.70	92	211
384	86.5	18	29	15.1	12.9	10.6	7.9	21.20	12.2	65.30	100	266
387	99.0	14	37	14.4	10.5	9.5	6.4	17.00	16.0	82.00	96	210
393	110.5	16	35	14.5	11.4	10.8	7.6	30.75	16.7	79.75	100	206
394	120.5	22	36	16.1	13.1	11.5	8.4	27.80	15.1	92.70	96	220
395	118.7	14	37	14.7	11.3	10.0	7.8	30.15	16.8	88.55	100	216
396	122.0	16	33	15.4	12.6	11.0	8.5	33.60	16.6	78.40	96	230
397A	110.5	12	33	15.6	11.8	10.6	7.0	23.60	15.0	86.90	100	225
397B	95.8	16	29	14.8	13.0	10.1	7.7	21.80	13.5	74.00	96	226
400	95.0	16	31	15.1	11.8	10.3	7.2	24.15	14.2	70.85	84	256
Averages	100.19	16.31	32.71	14.85	12.06	10.18	7.60	23.43	15.17	76.85	96	

From these tables the following points will be noted:

1. There is a considerable range of variation in the selected ears. This was intentional. It was desired to have different degrees of each character represented in the ear-to-row test plots.

2. The characteristic differences of the two types of corn are well brought out in these tables. Thus it appears that while the average weight of the ear is about 5 grams greater for the Type II corn than for the Type I, this difference is largely in the weight of the cob in the two cases, rather than in the weight of the grains. The Type II has a bigger cob in proportion to the amount of corn it carries than does the Type I. In the Type I selections the net weight of shelled corn is on the average 70 percent. of the total weight of the ear. Whereas in the Type II ears the net weight of shelled corn is but 77 percent.

3. In the case of these selected ears the mean length is practically identical in both samples. But the mean number of kernels to the average row is 2 more in the Type I than in the Type II. This brings out again in another way the fine grained character of this Type I corn.

All discussion of variation in the characters of the ears tabled is deferred to another place.

In addition to the numerical data comprised in Tables 1 and 2, other matters not easily taken account of quantitatively were considered in making selections. These included such things as the straightness of the rows, covering of tip and butt, color of grain, shape of kernel, etc.

Work in 1908.

In the spring of 1908 the 165 selected ears obtained from the 1907 work were planted at Farmington. Each type of corn had a plot to itself, so located that there was no risk of a transference of pollen from one to the other. These plots were also so located as to reduce to the lowest possible degree the likelihood of foreign pollen from neighboring farms fertilizing this corn. As a matter of fact there is no reason to suppose that any crossing did occur. These plots were planted on the farm of Mr. J. H. Heath, who also attended to the cultivation of the corn during its growth. Throughout the growing season of 1908 one of the writers (F. M. Surface) was in the field studying the growth and other matters connected with this corn.

Plot I was planted with the Type I (Dennett and Ellis) seed. This plot was located on bottom or "intervale" land lying contiguous to the Sandy River to the west of Mr. Heath's house. The Type II seed (Crosby) was planted in Plot II. This plot was on upland ground, and was located east of Mr. Heath's house and directly in the rear of the Burnham and Morrill corn factory. The soil in both plots was a light sandy loam, of the type best adapted for the growing of sweet corn, and was in an excellent condition as regards natural fertility. Plot I in 1907 was in the grass period of a regular rotation practiced by Mr. Heath. An excellent crop of hay was raised from the field of which this corn plot was a part in that year. Plot II was in potatoes in 1907. On Plot II a heavy dressing of barnyard manure was plowed under in the fall of 1907. Because of the risk of a spring overflow of the Sandy River it was not advisable to do this in the case of Plot I. That plot was well manured and plowed in the spring of 1908. Both were thoroughly harrowed and had a good seed bed prepared. Deeper harrowing would have been of benefit in the case of Plot I.

The size of Plot I was 300 x 150 feet, or, after allowing for paths, etc., there was exactly one acre in sweet corn. In Plot II the dimensions were 200 x 200 feet. Plot I included 100 rows. The rows ran approximately east and west and were in two sections, 50 rows in each. A path two hills wide was left in the middle of the field between the two sections. Plot II included 66 rows, also running approximately east and west. In both plots the rows were 3 ft. apart, and the hills 18 inches (approximately) apart. On Plot I, 1100 lbs. of Bradley's Corn Phosphate was used, and on Plot II 900 lbs. The fertilizer was applied with a corn planter which dropped it in hills approximately 18 inches apart. The coverers were removed from the planter. This left the fertilizer partially mixed with the soil and exposed in the hill. Then the seed was planted by hand, 3 kernels to a hill. Each row was planted with the seed from one single ear, and a record kept of the ear used for that particular row. Plot I was planted May 19, 1908, and Plot II May 20, 1908. In both plots the seed bed was in excellent condition at the time of planting; the soil was well pulverized, warm and dry. Plot II was a little more moist when planted than Plot I but was not too damp to plant.

On May 28, 1908, the corn in Plot I was coming up nicely; Plot II was not so far along at this time, but scattered hills were up. Plot I gave an excellent even stand. Plot II did not do so well in this regard. Some rows in particular had a number of missing hills. After the corn was well up it was cultivated once a week by running a one-horse cultivator between the rows. It was hoed by hand twice. At the second hoeing, when the stalks were 12-14 inches tall it was thinned so as to leave one plant to the hill. It should not be understood that such a degree of thinning is to be recommended. It was done in this case merely because it was desired to be able to study in detail each individual plant. This can be done most advantageously with only one plant to the hill.

The season of 1908 was a favorable one for growing sweet corn except for the prolonged and severe drought, which was the worst experienced for many years in the part of the State where the experimental plots were located. Fortunately the corn in these plots was not so badly injured as much of that in nearby localities.

The most striking result in 1908 was the marked increase in earliness exhibited in the selected corn of Type I, both in comparison with the same type of corn on the same land the season before, and with other corn of the same type planted in the region about Farmington from factory seed in the same year (1908). The amount of this gain in earliness accompanying one year's selection is indicated by the following figures. The first tassel in Plot I was found July 3, 1908. During the next few days many more appeared. By July 6, 1908, the corn was well tasseled out over the whole plot. The first silk came out on July 14, 1908. In the period July 17-20, 1908, the silk was well out over the whole field. By July 27 and 28, 1908, the silk was drying on a large number of plants. By August 20, 1908, the corn in this plot was as a whole in the proper condition to go into the factory, although a good deal of it was past good canning condition at that date. On August 28, 1908, 180 ears were harvested for seed. These were ears thoroughly matured for seed purposes: stalks dead and dried up. The corn on the whole plot was thoroughly matured and ready to harvest *for seed* September 6, 1908. Harvesting began at that time, and on account of the number of records, etc., to be taken, continued till September 12. No other sweet corn grown in the region about Farmington in 1908 was as early as this selected corn in Plot I, by at least two weeks. In August, 1908, the writers made a rather extended trip through the corn growing region of the southern and western parts of the State. Nowhere was any corn seen which was as early as Plot I at Farmington.

Besides the gain in earliness, there was a marked improvement in the quality of the seed as regards conformation of ear, covering of tip, etc. This was commented upon by all who saw the corn. Some indication regarding this point is given by comparing Figs. 224, 225, 226 and 227, which represent some of the seed ears obtained in 1907 and Figs. 228, 229 and 230, which in the same way show some of the selected ears of 1908.

Plot II did not give as good results as Plot I, in any particular. It compared however, very favorably with the best of the corn grown from factory seed in the region around Farmington. Data regarding the earliness of the corn in this plot are given in the following figures. The first tassel was noted July 8, 1908.

Only a comparatively few plants had tasseled out up to July 14. Silks began appearing July 24 and by July 28 about a half of the stalks in the plot were in full silk. The corn on this plot, with the exception of selected rows saved for seed, was cut and hauled to the factory on September 2. It was then at the proper stage of growth for canning. At this date only a comparatively small amount of corn from factory seed had been brought into the Farmington factory. It was over a week later before the factory began operating at full capacity. The seed ears from selected rows in this plot were harvested for seed September 22, 1908.

From the data given it is evident that the corn in Plot I was much earlier than that in Plot II. A part of this difference is probably to be explained by the innate difference between the two types in regard to this character already noted. Another and perhaps more important factor is to be found in the fact that the Type II corn was in a new environment at Farmington. It was not so well adapted or adjusted to Farmington conditions of soil, climate, etc., as was the Type I corn. This point will be more fully discussed further on.

In the case of the corn on Plot I all of the ears were harvested for seed, the product of each row being of course kept separate. After a preliminary drying at Farmington the corn was shipped to Orono and given a thorough drying on racks in the Experiment Station attic, as described for 1907. After being thoroughly dried the ears from each row were sorted into three classes, A1 seed, good seed and nubbins. The number of ears in each class was counted. Then the ears of each class were shelled and the weight of dry shelled corn from that class determined. These weights were, from necessity, taken in pounds rather than on the metric system. From these was calculated the yield of each row in bushels of corn fit to use for seed per acre. This calculation was made on the assumption that a bushel of dry shelled sweet corn weighs fifty pounds.

The different classes of ears were defined as follows: To be put in the A1 class an ear must have a good butt and a well covered tip, be of good size and shape (nearly cylindrical), have the grains small and well packed and the rows straight. The ears put in this class were of very fine quality. The "good seed" included all other ears which were not undersized or mis-

shapen. No ears were put in this class which would not be graded as good seed ears by a factory distributor or seedsman. The nubbins included all small, malformed or defective ears which could never be used for seed purposes. The "total seed" of the tables below is the sum of A1 and good seed.

The data obtained from this sorting and weighing of the product of the ear-to-row plots are given in Tables 3 and 4, Table 3 dealing with Type I, and Table 4 with Type II corn. In the case of Type II corn only 11 rows were considered of sufficient merit to warrant saving them as a whole for seed. All of the rows of Plot I were saved, though not all were actually used for seed.

The arrangement of data in Tables 3 and 4 is as follows: in the first column is given the number of the row; in the second column the number of the "parent ear" for this row. Thus ear No. 143 was the ear used in planting row No. 100. Detailed data regarding the characteristics of each of the "parent ears" of Tables 3 and 4 are given in Tables 1 and 2 above. The next two main columns give for the A1 seed and good seed respectively the following information: (a) the number of ears falling in the A1 class, (b) the weight (in pounds) of corn shelled from these ears, and (c) the weight of the cobs of these ears. The next main column gives the same information in regard to all ears fit for seed. The figures here are obtained by adding those given in the two preceding columns. The sixth main column of the tables gives the calculated yield of *seed* per acre, based upon the yields in the "total seed" column. The last main column of the tables gives the figures in regard to nubbins and ears too poor to be classed as good seed.

TABLE 3.

Yield of Each Row of Type I Corn in 1908.

Row No.	Parent ear No.	A 1 Seed.			Good Seed.			Total Seed.			Bushels of seed per acre.	Nubbins.		
		No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.		No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.
100	143	10	2.13	0.44	78	13.38	3.31	88	15.50	3.75	31.00	31	2.00	0.69
101	113	22	4.31	0.94	130	19.69	4.44	152	24.00	5.38	48.00	27	1.69	0.44
102	48	24	5.00	1.06	93	16.56	3.75	117	21.56	4.81	43.12	61	3.31	1.19
103	138	23	4.13	0.88	104	15.88	4.00	127	20.00	4.88	40.00	66	3.63	1.44
104	10	18	3.56	0.75	72	11.81	2.81	90	15.37	3.56	30.74	53	3.25	1.25
105	173	15	3.06	0.69	84	14.38	3.69	99	17.44	4.38	34.88	44	2.44	1.06
106	162	18	3.44	0.75	92	15.06	3.31	110	18.50	4.06	37.00	59	3.81	1.25
107	11	20	3.81	0.88	64	10.44	2.44	84	14.25	3.32	28.50	49	2.63	1.06
108	16	27	5.88	1.19	94	16.62	3.56	121	22.50	4.75	45.00	47	3.88	1.19
109	21	32	6.25	1.38	79	12.44	2.81	111	18.69	4.19	37.38	53	3.19	1.00
110	227	24	5.31	1.13	64	12.19	2.75	88	17.50	3.88	35.00	48	3.94	1.25
111	157	15	3.06	0.56	115	20.69	4.44	130	23.75	5.00	47.50	46	2.69	0.88
112	40	34	7.31	1.56	70	12.69	3.00	104	20.00	4.56	40.00	50	3.69	1.19
113	50	25	5.25	1.19	75	13.44	2.94	100	18.69	4.13	37.38	28	1.81	0.69
114	47	23	4.31	0.94	78	12.88	2.94	101	17.19	3.88	34.38	33	2.13	0.56
115	222	36	7.00	1.63	92	15.38	3.56	128	22.38	5.19	44.76	34	2.06	0.69
116	187	13	2.44	0.50	73	12.00	2.50	86	14.44	3.00	28.88	45	3.00	0.94
117	22	17	3.44	0.75	87	13.31	2.94	104	16.75	3.69	33.50	43	2.31	0.75
118	41	29	6.06	1.25	67	11.38	2.69	96	17.44	3.94	34.88	47	3.00	1.00
119	217	22	4.50	1.00	79	12.69	2.88	101	17.19	3.88	34.38	36	2.50	0.75
120	201 B	10	2.00	0.44	95	15.69	3.31	105	17.69	3.75	35.38	28	1.94	0.63
121	12	15	3.13	0.63	90	14.31	3.13	105	17.44	3.75	34.88	49	3.00	1.06
122	34	29	6.25	1.38	68	11.50	2.63	97	17.75	4.00	35.50	46	2.63	1.00
123	218	11	3.13	0.69	74	15.00	3.06	85	18.13	3.75	36.26	29	2.13	0.63
124	23	12	2.56	0.50	89	14.56	3.00	101	17.13	3.50	34.26	36	3.56	0.88
125	225	28	5.75	1.19	69	12.19	2.56	97	17.94	3.75	35.88	63	4.93	1.88
126	36	30	6.50	1.50	75	13.19	3.06	105	19.69	4.56	39.38	37	2.44	0.94
127	204	18	3.44	0.69	88	16.13	2.94	106	19.56	3.63	39.12	26	2.06	0.56
128	39	12	2.44	0.44	85	14.56	2.94	97	17.00	3.38	34.00	38	3.00	0.88
129	199	40	9.06	1.44	84	12.44	2.50	124	21.50	3.94	43.00	41	2.63	0.69
130	216	19	3.88	0.56	114	18.25	5.06	133	22.13	5.63	44.26	37	1.81	0.88
131	193	21	4.25	0.88	87	14.63	3.19	108	18.88	4.06	37.76	56	3.06	1.25
132	110	26	5.63	1.13	61	10.81	2.25	87	16.44	3.38	32.88	96	7.06	2.00
133	24	30	7.88	1.75	107	16.13	4.19	137	24.06	5.94	48.12	68	4.13	1.50
134	148	23	4.81	1.00	72	12.69	2.63	95	17.50	3.63	35.00	40	2.75	0.75
135	149	15	2.94	0.63	83	13.00	2.88	98	15.94	3.50	31.88	59	4.00	1.13
136	13	34	7.19	1.44	86	13.75	2.81	120	20.94	4.25	41.88	54	3.50	0.88
137	154	32	6.31	1.38	74	11.25	2.81	106	17.56	4.19	35.12	43	3.25	0.88
138	164	31	5.44	1.25	76	13.44	2.94	107	18.88	4.19	37.76	81	5.88	2.81
139	170	16	3.56	0.75	85	15.00	3.44	101	18.56	4.19	37.12	67	5.25	1.50
140	180	13	2.50	0.50	112	18.06	4.13	125	20.56	4.63	41.12	62	4.38	1.19
141	128	18	3.69	0.75	101	14.50	2.88	119	18.19	3.63	36.38	53	3.50	1.00
142	38	22	4.25	0.88	120	18.81	4.19	142	23.06	5.06	46.12	62	4.00	1.13
143	178	26	5.38	1.19	76	12.44	2.81	102	17.81	4.00	35.62	69	5.25	1.56
144	169	32	6.50	1.31	67	11.50	2.50	99	18.00	3.81	36.00	50	3.25	0.88
145	168	30	6.19	1.25	85	13.06	2.81	115	19.25	4.06	38.50	55	3.69	1.13
146	139	34	6.94	1.31	96	15.81	3.44	130	22.75	4.75	45.50	88	6.63	1.94
147	129	38	8.44	2.06	64	11.13	2.69	102	19.56	4.75	39.12	73	6.44	2.00

TABLE 3—Concluded.

Row No.	Parent ear No.	A 1 Seed.			Good Seed.			Total Seed.			Bushels of seed per acre.	Nubbins.		
		No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.		No. of ears.	Weight of shelled corn in lbs.	Cob weight in lbs.
148	144	44	9.44	2.00	81	12.69	2.75	125	22.13	4.75	44.26	81	5.63	1.69
149	9	24	5.13	2.00	119	21.19	4.50	143	26.31	6.50	52.62	37	2.38	0.63
150	174	15	3.13	0.69	110	15.25	3.75	125	18.38	4.44	36.76	91	5.19	1.81
151	35	13	2.75	0.56	91	15.44	3.69	104	18.19	4.25	36.38	54	3.56	1.38
152	125	16	2.88	0.63	78	12.81	3.13	94	15.69	3.75	31.38	67	4.00	1.38
153	64	26	5.63	1.19	83	14.19	3.19	109	19.81	4.38	39.62	33	2.31	0.75
154	59	13	2.56	0.56	87	15.44	3.50	100	18.00	4.06	36.00	41	2.81	0.87
155	58	24	5.00	1.13	69	12.63	3.00	93	17.63	4.13	35.26	38	2.88	0.88
156	147	2	0.88	0.06	106	17.44	3.88	108	18.31	3.94	36.62	49	3.19	1.00
157	62	30	6.13	1.38	71	11.50	2.56	101	17.63	3.94	35.26	52	3.69	1.19
158	137	21	5.44	1.06	88	14.88	3.31	109	20.31	4.38	40.62	42	3.44	1.00
159	176	23	5.31	1.13	58	11.63	2.63	81	16.94	3.75	33.88	54	4.25	1.38
160	134	15	3.13	0.63	89	15.88	3.25	104	19.00	3.88	38.00	55	4.06	1.13
161	51	10	2.13	0.38	97	16.56	3.50	107	18.69	3.88	37.38	48	3.31	1.00
162	167	16	3.75	0.69	76	13.38	2.88	92	17.13	3.56	34.26	36	3.00	0.75
163	160	24	4.44	1.00	80	12.56	3.00	104	17.00	4.00	34.00	51	4.06	1.25
164	177	28	5.94	1.25	45	7.69	1.63	73	13.63	2.88	27.26	32	2.44	0.63
165	1	14	2.88	0.63	54	10.00	2.25	68	12.88	2.88	25.77	54	3.94	1.19
166	5	29	5.25	1.25	46	7.25	1.75	75	12.50	3.00	25.00	21	1.38	0.44
167	29	28	5.69	1.25	52	7.63	1.56	80	13.31	2.81	26.62	33	3.94	0.69
168	33	16	3.50	0.75	76	12.88	2.75	92	16.38	3.50	32.76	31	2.50	0.69
169	8	26	5.06	1.00	72	11.56	2.50	98	16.63	3.50	33.26	49	2.94	0.88
170	194	16	3.56	0.69	62	9.50	2.25	78	13.06	2.94	26.12	37	2.69	0.81
171	223	8	1.63	0.31	92	15.38	3.38	100	17.00	3.69	34.00	32	2.50	0.75
172	68	19	3.94	0.88	72	11.81	2.44	91	15.75	3.31	31.50	22	1.75	0.50
173	17	14	2.56	0.50	85	13.69	3.06	99	16.25	3.56	32.50	40	2.88	0.88
174	6	23	4.31	0.81	70	12.75	2.56	93	17.06	3.38	34.12	44	2.81	0.88
175	45	11	2.00	0.38	60	8.63	1.75	71	10.63	2.13	21.26	46	3.13	0.88
176	60 B	15	3.06	0.56	75	12.75	2.56	90	15.81	3.13	31.62	60	4.69	1.13
177	132 A	18	3.69	0.81	69	11.00	2.63	87	14.69	3.44	29.38	24	1.56	0.44
178	60 A	10	1.94	0.63	61	10.06	2.19	71	12.00	2.81	24.00	62	4.63	1.31
179	132 B	21	3.88	0.94	69	10.50	2.56	90	14.38	3.50	28.76	19	1.25	0.38
180	165	8	1.56	0.31	58	9.31	1.88	66	10.88	2 19	21.76	46	3.75	1.00
181	206	10	1.75	0.31	83	12.06	2.25	93	13.81	2.56	27.62	31	2.13	0.56
182	67	27	5.31	1.13	75	12.31	2.56	102	17.63	3.69	35.26	19	1.63	0.44
183	198	14	2.88	0.63	74	12.63	2.75	88	15.50	3.38	31.00	40	3.19	0.94
184	172	23	4.38	0.94	85	12.75	2.94	108	17.13	3.88	34.26	30	2.06	0.63
185	151	12	2.50	0.50	66	11.63	2.50	78	14.13	3.00	28.26	41	2.94	0.94
186	171	12	2.50	0.50	71	11.00	2.50	83	13.50	3.00	27.00	21	1.94	0.44
187	49	7	1.50	0.25	68	11.38	2.38	75	12.88	2.63	25.76	40	3.00	0.88
188	141	19	3.88	0.81	80	13.56	2.94	99	17.44	3.75	34.88	54	2.75	1.13
189	116	32	6.31	1.25	86	13.31	2.81	118	19.63	4.06	39.26	63	2.94	0.81
190	130	24	5.06	1.13	77	13.75	3.19	101	18.81	4.31	37.62	43	2.56	0.94
191	136	27	5.38	1.13	66	12.00	2.56	93	17.38	3.69	34.76	31	2.50	0.75
192	78	21	4.50	1.00	80	12.81	2.88	101	17.31	3.88	34.62	29	2.00	0.75
193	115	16	3.38	0.75	73	12.44	2.81	89	15.81	3.56	31.62	39	2.31	0.75
194	42	14	2.63	0.50	89	13.63	3.13	103	16.25	3.63	32.50	46	3.63	1.00
195	7	19	3.63	0.81	79	13.00	2.94	98	16.63	3.75	33.26	38	2.56	0.75
196	46	23	4.75	1.06	45	7.38	1.94	68	12.13	3.00	24.26	33	2.31	0.75
197	72	21	4.81	1.00	75	14.00	2.94	96	18.81	3.94	37.62	35	2.63	0.75
198	127	35	7.00	1.44	86	13.69	2.88	121	20.69	4.31	41.38	30	2.00	0.63
199	133	21	4.25	0.88	86	13.75	3.19	107	18.19	4.06	36.38	26	1.88	0.56
Averages.		21.09	4.35	0.92	80.18	13.30	2.96	101.27	17.65	3.88	35.29	45.86	3.17	0.99

TABLE 4.

Yield of Each Row of Type II Corn in 1908.

Row No.	Parent ear No.	A 1 Seed			Good Seed			Total Seed			Bushels per acre	Nubbins		
		No. of ears	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears	Weight of shelled corn in lbs.	Cob weight in lbs.	No. of ears	Weight of shelled corn in lbs.	Cob weight in lbs.		No. of ears	Weight of shelled corn in lbs.	Cob weight in lbs.
202	375	34	7.25	1.69	81	15.13	3.56	115	22.38	5.25	29.54	32	2.81	0.75
203	88	50	10.69	2.81	82	15.13	3.88	132	25.82	6.69	34.08	46	3.19	1.00
204	84	45	10.19	2.63	69	14.56	3.56	114	24.75	6.19	32.67	27	2.25	0.69
210	387	39	8.13	1.88	69	12.88	3.13	108	21.00	5.00	27.72	15	1.31	0.38
214	333	27	5.94	1.50	96	18.38	4.06	123	24.31	5.56	32.09	33	2.69	0.81
218	357	30	6.44	1.50	81	15.31	3.81	111	21.75	5.31	28.71	20	1.69	0.50
221	106	31	6.06	1.63	111	21.06	5.50	142	27.12	7.13	35.80	29	2.13	0.69
224	364A	37	8.00	2.00	78	16.31	4.13	115	24.31	6.13	32.09	22	1.88	0.50
230	396A	50	10.63	2.94	60	12.25	3.13	110	22.88	6.06	30.20	24	2.25	0.69
231	105A	30	6.13	1.50	72	12.69	3.06	102	18.81	4.56	24.83	25	1.94	0.56
253	292	21	4.25	0.94	57	10.00	2.31	78	14.25	3.25	18.81	12	0.94	0.25
Averages		35.8	7.61	1.91	77.8	14.89	3.65	113.9	22.49	5.56	29.68	25.9	2.98	0.62

A number of interesting points come out of these tables. Among these are the following:

1. Taking the Type I corn first it appears that on the average over the whole plot 21 out of every 101 ears fit to be used for seed at all were of such superior quality as to be placed in the A1 class. This is a high ratio as compared with the seed which the packers ordinarily distribute to the farmer.

2. The same fact is brought out in a more striking way by considering the weight of shelled corn produced on the different classes of ears. On the average 24.6 per cent. by weight of the shelled corn of seed quality came from ears graded as A1.

3. As would be expected from the above relations there was only a small proportion of the total crop unfit for seed. Taking the average of all the rows only 15.2 per cent. of the total yield of shelled corn was borne on nubbins or poor ears which could not be classed as good seed.

4. The average yield in bushels per acre of dried and shelled seed corn for all rows was 35.29. Considering the fact that this is for a stand of only one stalk to a hill it can only be regarded as a very good yield. The distribution of the yields for each of the 100 rows is shown graphically in Fig. 223.

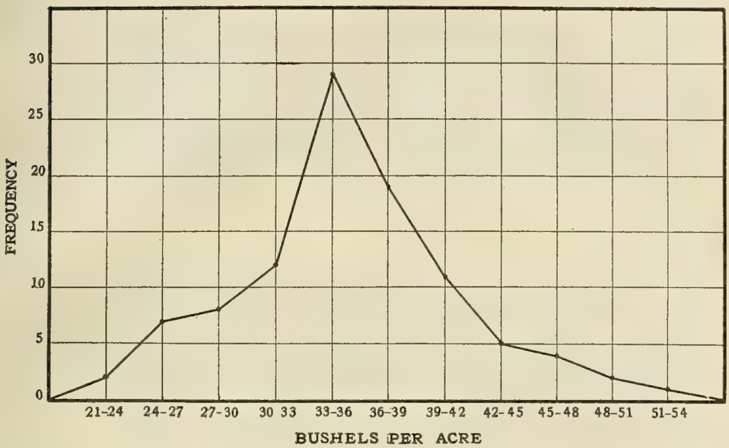


Fig. 223. Diagram showing the yield of the 100 rows of Type I corn in bushels per acre.

From this diagram it appears that the yield which occurred most often was in the class 33-36 bushels. From this high point the polygon slopes off at about the same angle in both directions—*i. e.,* towards higher as well as lower yields.

5. Even the 11 best rows of the Type II corn, selected because they were the best in the field, did not average to yield as well as the whole of the 100 rows of the Type I, good, bad and indifferent taken together. The Type II falls behind nearly 6 bushels to the acre.

6. Further, even in these 11 best rows the Type II corn did not produce nearly so high a proportion of its total shelled corn on ears of good quality which warranted their use for seed. Thus, taking averages of the 11 rows it appears that of the total yield 48.2 per cent. was borne on nubbins or ears not good enough to use for seed. This figure is to be compared with the 15.2 per cent. in the case of the Type I corn.

7. The shelling ratio is also slightly higher in the Type I averages for the whole field than in the case of the 11 selected rows of Type II. From Table 3 it appears that in the case of the "A1 seed" of Type I, 17.5 per cent. of the average weight of the ear was cob (shelling percentage=82.5), and in the "good seed" of the same type of corn, 18.9 per cent. of the average weight of the ear was cob (shelling percentage=81.1). On the other

hand, the Type II "A1 seed" has 19.1 per cent. of the total weight in cob, and the "good seed" has 19.6 per cent. in cob (shelling percentage 80.9 and 80.4 respectively). It should again be pointed out that a part at least of the poor showing of the Type II (Crosby) corn as compared with the Type I (Dennett) is to be explained as a result of the fact that the former was planted in the ear-to-row test in a locality to which it was not "adjusted," while the Type I was.

In addition to the collection of data regarding the rows as wholes, individual plant selections were made in 1908, just as in 1907, except that in this year the selections were made in the ear-to-row plots. The ears from these field selections were used in an ear-to-row test in 1909, with results to be described farther on in connection with the work of that year. Data were taken on these ears selected in 1908 similar to those already given for the 1907 ears.

The question of the relation of type, conformation and size of ear to yield and quality in the progeny is one of great importance to the corn breeder. While it is not possible in a general discussion, such as this is intended to be, to go deeply into this matter it is thought desirable to present some photographic material which we have collected bearing on the subject. These pictures have the further advantage of recording in some measure the progress made in the selection work, so far at least as certain ear characters are concerned. There will be presented some photographs of the ears selected in 1907 for planting in 1908, together with a brief discussion of their progeny in 1908. It should be said that in all cases where an ear shown in these photographs is crooked it became so in drying, and was not so originally. The corn was dried on racks so constructed that each ear was thrust, at the butt end, on a nail projecting from the rack. The weight of the ear itself caused some to curve in the process of drying.

Figures 224 and 225 show two groups of ears selected in 1907, one of which produced relatively high yielding rows, and the other relatively low yielding rows.

It is instructive to compare individual ears. Ear No. 113 (Fig. 224) while bearing almost identically the same amount of shelled corn as ear No. 1 (Fig. 225) (80.90 gr., as against 80.10 gr.) produced a row yielding at the rate of 48.00 bushels

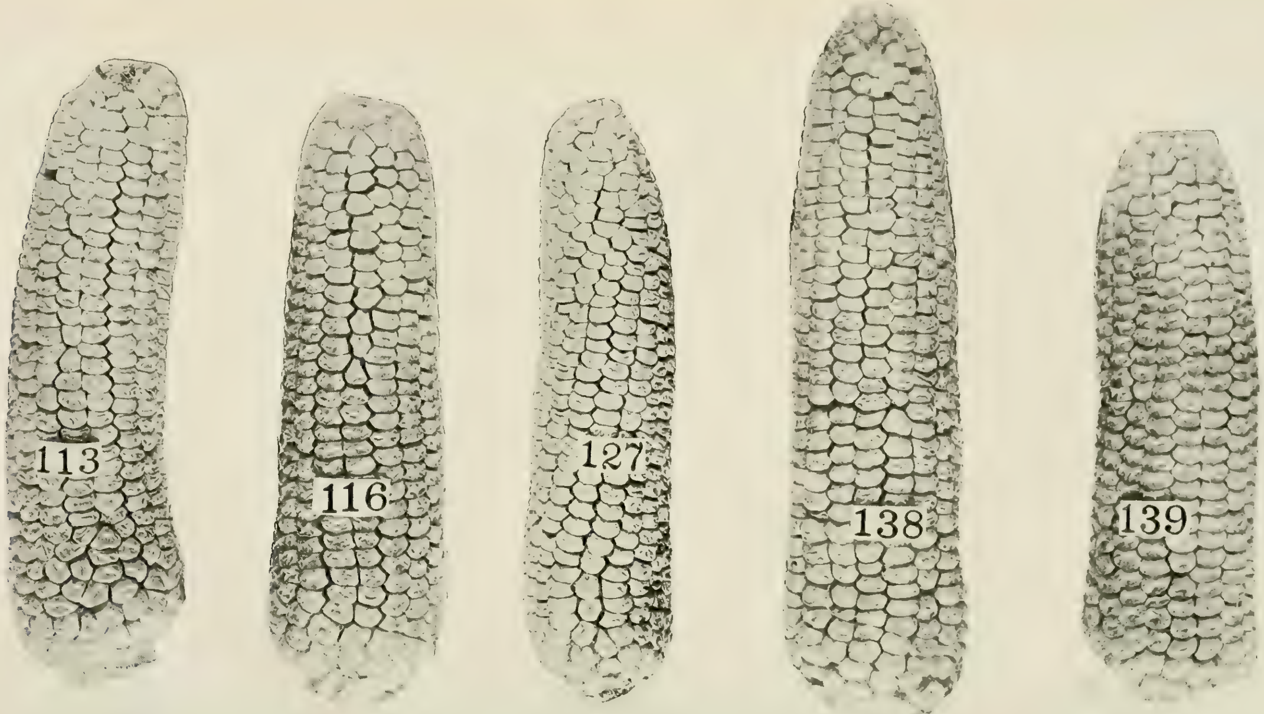


FIG. 224. Photographs of sweet corn ears selected in 1907. Produced relatively *high* yielding rows in 1908

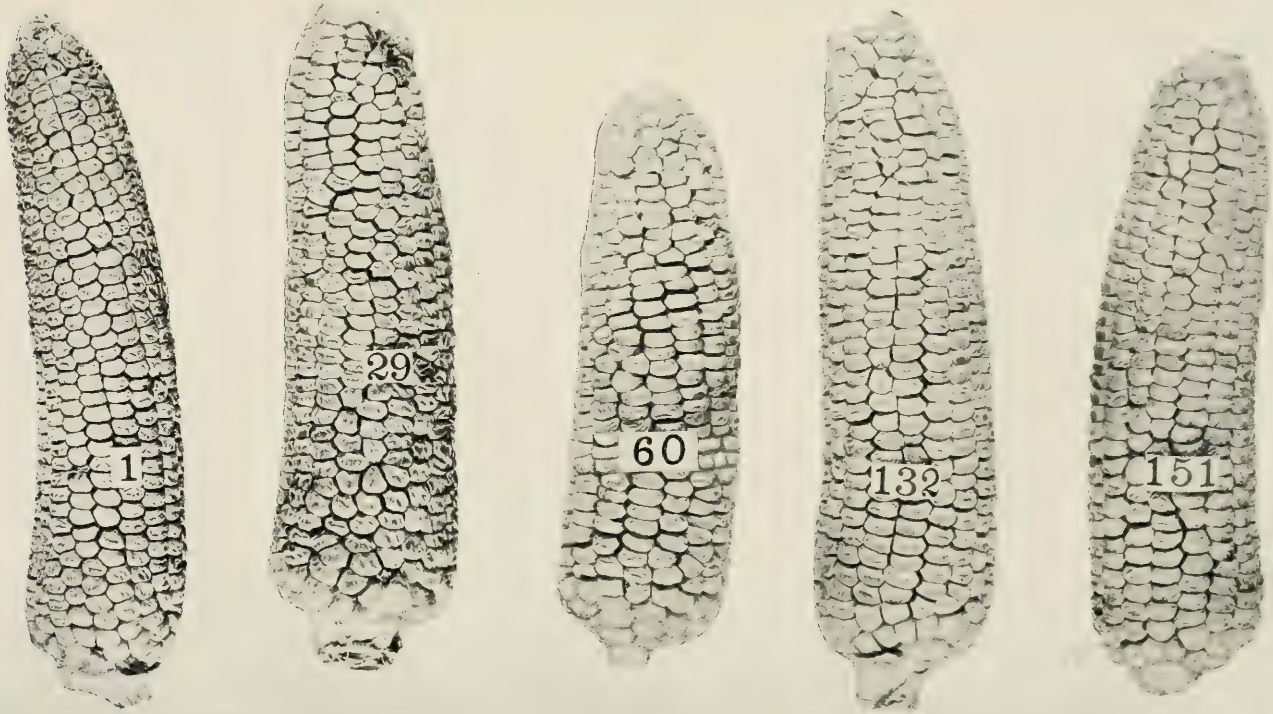


FIG. 225. Photographs of sweet corn ears selected in 1907. Produced relatively *low* yielding rows in 1908.

to the acre, while ear No. 1 produced a row yielding but 25.77 bushels to the acre. Ear No. 1 had but 76.22 per cent. of its total yield on ears good enough for seed, while ear No. 113 has 93.42 per cent. of its total yield on such ears.

Again ear No. 113 may be compared with No. 116. The latter was certainly the better looking ear, yet it yielded at the rate of 10 bushels to the acre less than No. 113.

Ear No. 127 (Fig. 224), which was a smaller ear (66.50 grams shelled corn) than any ear in Fig. 225 with the exception of ear No. 60, yielded at the rate of 41.38 bushels to the acre as against 29.38 bushels to the acre, the highest yield of any of the ears shown in Fig. 225, that of ear No. 132.

Ear No. 127 (Fig. 224) produced a row yielding at the rate of 1.38 bushels per acre higher than the row produced by ear No. 138 (Fig. 224), which was relatively a giant beside it.

Ear No. 139 (Fig. 224) produced one of the highest yielding rows in the test, giving 45.50 bushels to the acre, yet this ear had the smallest net weight of shelled corn (61.90 grams) of any of the 5 ears shown in Fig. 224. Ear No. 29 (Fig. 225) was one of the heaviest ears selected (bearing 88.10 gr. shelled corn) yet it produced a row yielding at the rate of but 26.62 bushels to the acre.

These facts are very striking. They indicate that there is not that close association between the size and type of the ear and the resulting yield, which many would have us believe. The proper method of studying this matter is, of course, to measure mathematically the correlation between ear characters and yield. This is being done in this laboratory, but a technical discussion of the results is not in order here. These photographs show clearly enough that such an association of characters and yield cannot be very close or definite. This is a result in accordance with some data recently published by Williams and Welton of the Ohio Station.*

The point may be raised that in Figs. 224 and 225 we are dealing with extremes in the positive and negative directions. What would be the type and size of ears producing good average yielding rows? Such rows would in our 1908 experiment be represented by yields of from 33 to 36 or 37 bushels. In figures 226 and 227 data are given for an examination of this question.

* Williams, C. G., and Welton, F. A. Ohio Agric. Exp. Sta. Bulletin 212, 1909.

The difference in appearance of the ears in these two figures is striking indeed. The ears in Fig. 227 are poor scrubby looking things, which anybody selecting seed for anything but an experiment would surely reject. On the other hand, the ears in Fig. 226 are of fine quality. Every one is of the cylindrical type so much sought after in corn, and each has a beautifully rounded tip evenly covered with grain. Each one of the ears shown in these two pictures was planted, *and each one produced a row yielding within 2 bushels (above or below) of the average of the whole plot.* The average rate of yield of the rows from the 5 ears of Fig. 226 was 36.10 bushels per acre, while that for the 5 ears in Fig. 227 was 35.00, or, in other words, *the average rate of yield per acre was only 1.1 bushels more for the rows from the ears of Fig. 226 than for those from the ears of Fig. 227.*

Another question which suggests itself is as to the quality of the ears in the rows produced from the ears shown in Figs. 226 and 227. Was it not the case that while the net weight of shelled corn was substantially the same for the two sets of rows from these different ears yet the proportion of this borne on nubbins and ears of too poor quality for seed was higher in the rows from the poor ears of Fig. 227 than from the good ears of Fig. 226. One would suppose this surely to be the case. Ears like 172 (Fig. 227) have been set forth to the readers of agricultural literature as glaring and shocking examples of what not to plant. Now as a matter of fact, out of the total amount of shelled corn produced by the progeny of these two set of ears, an average of 13.67 per cent. was produced on nubbins and ears too poor for seed in the case of the progeny of the ears of Fig. 226, against an average of 13.58 per cent. in the case of the progeny of the ears of Fig. 227. Or, in other words, *the progeny of the good ears of Fig. 226 produced just as much (and indeed an insignificant trifle more) corn on nubbins and ears too poor for seed as did the progeny of the poor ears of Fig. 227.*

Turning now to the other side of the case let us ask what was the proportion of high quality ears (A1 seed) produced by the progeny of the two sets of ears shown in Figs. 226 and 227. We may again take the total weight of shelled corn as the base of comparison. The progeny of the poor ears of Fig. 227, tak-

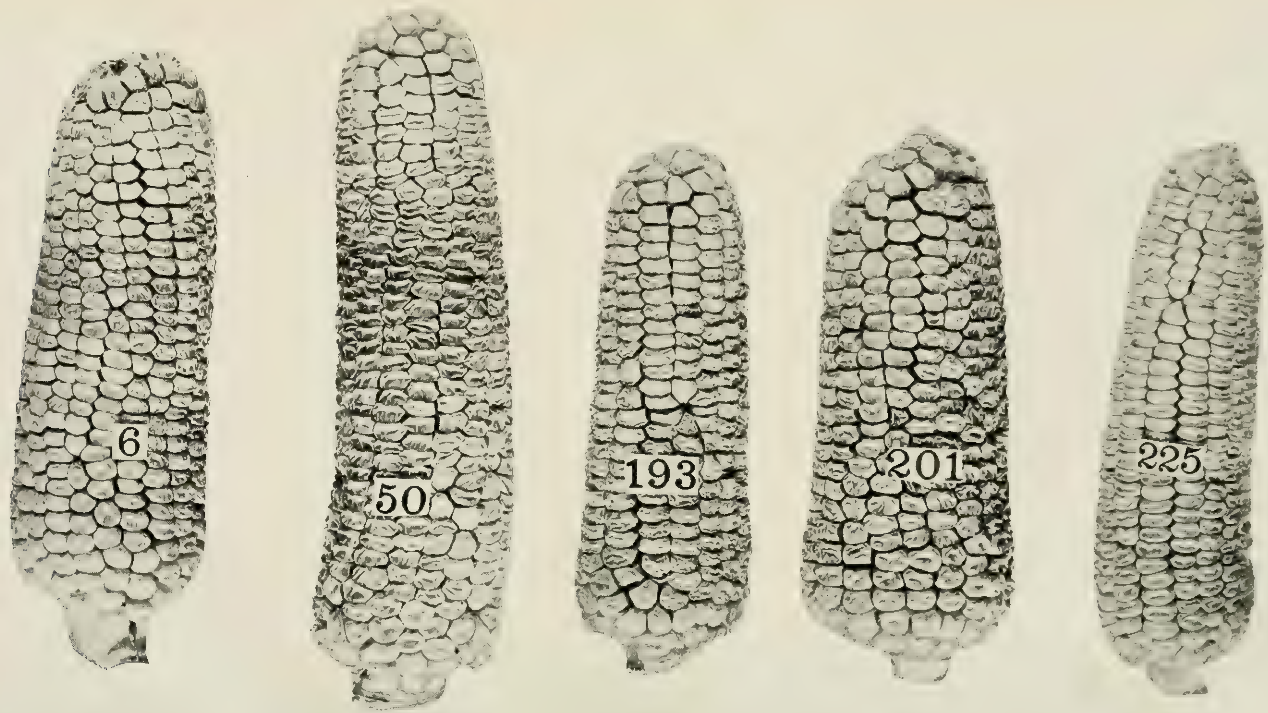


FIG. 226. Sweet corn ears selected in 1907 for planting in 1908. These are ears of *good* type producing good average yielding rows.

Fig. 227. Sweet corn ears selected in 1907 for planting in 1908. These ears are of *poor* type producing good average yielding rows.

ing the average for the 5, produced 20.68 per cent. of their total shelled corn on ears of A1 quality, while the progeny of the good ears of Fig. 226 produced 20.40 per cent. of their total shelled corn on such ears. *In other words, the progeny of the ears of Fig. 226 included on the average no more ears of fine quality than did the progeny of the ears of Fig. 227.*

How are such results as these to be interpreted? It is, of course, open to one to maintain if he chooses that the cases illustrated are merely isolated instances—exceptions which prove the rule as it were. As a matter of fact these cases are not exceptions. They agree essentially with the great bulk of data regarding inheritance accumulated by the experimental work of recent years in supporting the generalization that the external, visible characteristics of a plant or animal furnish an exceedingly unreliable criterion of its probable behavior in breeding. The fact that an ear of corn is of especially good type and appearance is no guarantee that its progeny will also be better than the average. These corn ears illustrate exactly the same principles that have been brought out in the studies on breeding for egg production at this Station.* The force of such facts as are here set forth and the general principles upon which they depend, is making itself felt in practical corn breeding work in the western states. The writers gather from their reading of such papers as the Breeders Gazette (and they are informed by competent authority that their conclusion on this point is quite correct) that among the most careful and thoughtful of the corn belt farmers and breeders of seed corn there is developing a marked reaction from the belief in the great value of the "show" type of ears for seed raising purposes. It is being found by corn breeders everywhere that such ears do not always or even in the majority of cases produce the highest yields or the largest proportion of perfect ears.

Facts of the character brought out by these protographs of corn ears are capable of satisfactory interpretation on the basis of Johannsen's ** concept of genotypes. According to this view the ears shown in Fig. 227 represent very poor individual speci-

* Cf. Me. Agr. Expt. Stat. Bulletin 166 and Bureau of Animal Ind. Bulletin 110, Part I.

** Cf. this author's recent book "Elemente der exakten Erblichkeitslehre." Jena (Fischer), 1909.

mens belonging to mediocre genotypes, whereas the ears in Fig. 226 represent very good individual specimens but also from mediocre genotypes. If both sets belong to genotypes of about the same general grade or character it is to be expected that the progeny of both sets of ears will be essentially the same. This as a matter of fact was the case. The genotype concept gives at once a more reasonable interpretation of the facts than is to be gained from any other current view of the nature of the process of inheritance, and suggests the factors of primary importance to be looked after in practical corn breeding. Evidently if the genotype idea represents the actual method of inheritance in corn, the important test in selecting seed is the performance of the progeny. The aim must be to propagate the strains or lines in which high yield, fine quality of ears, etc., are *hereditarily* present. At the same time one must, of course, guard against any loss of vigor by too much or too close inbreeding.* It is obvious that in an open fertilized plant like corn one will never (except by hand pollination) get pure lines such as Johannsen has studied in beans. But to suppose, as some writers have apparently done that, because of this fact, the genotype concept has no significance for sexually reproducing animals and open fertilized plants, is merely a confession of a lack of understanding of the fundamental meaning of that concept.

Work in 1909—I. Ear-to-Row Test.

The ear-to-row test of the ears from individual plant selection was carried out on the farm of Mr. J. H. Heath at Farmington again in 1909. Land was taken for the work on the "intervale" contiguous to that used in Plot I in 1908. The soil was of the same character. In addition to the ear-to-row test a number of other test plots were carried on in 1909. Besides the experimental plots Mr. Heath grew two acres of corn for himself from seed selected for him by the writers. This corn was on the same "intervale" land immediately west of the experimental plots This gave nearly 3 acres of the Type I pedigreed sweet corn grown in the same field at Farmington under direct observation, and in the local conditions to which it was thoroughly adjusted.

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* This point has been much discussed in recent writings on corn breeding problems, especially by Shull, East, Cook, Spillman, and Collins.

The season of 1909 was an extremely unfavorable one for corn. Following a cold and wet spring the early part of the summer was characterized by a long succession of cloudy, cold days. The result was that sweet corn throughout the State got a very bad start. The relative amount of growth made in July was much below the normal for a favorable season. This, coupled with the fact that the late spring delayed the planting, made the sweet corn through the State in general mature late. To make the season about as unsatisfactory as possible from the corn grower's standpoint killing frosts came early in the fall and severely damaged the crop. These seasonal conditions must be kept in mind throughout the following discussion.

The data regarding the planting of the ear-to-row test plot in 1909 are as follows: The plot, as has been said, was located on the "intervale" as in 1908. Only Type I corn was used in the planting. One ear was planted to a row as before. The plot was smaller and the rows shorter than in 1908. The rows were 3 feet apart and the hills 18 inches. The plot measured 148 feet x 75 feet, 49 rows being planted. The land used was in grass in 1908. It was given a good coat of manure, plowed in the spring of 1909 and in general given the same treatment as described for the 1908 ear-to-row test. Bradley's Corn Phosphate was applied at the rate of 900 lbs. to the acre. This was put in the hills in the way described for the 1908 work. The plot was planted May 20, 1909. In this year's work the thinning was done so as to leave 2 stalks to the hill rather than one as in 1908. The cultivation was otherwise as in 1908.

The data regarding the ears planted in the ear-to-row test in 1909 are given in Table 5. There is also included in the last 2 columns of this table a statement of the yield of each row.

TABLE 5.

Data on Type I Corn Ears Planted in Ear-to-Row Test in 1909, and the Yield of the Resulting Rows.

Ear No.	Parent Ear No.	Weight.	Rows.	Kernels to row.	Butt circumference in cms.	Tip circumference in cms.	Cob butt circumference in cms.	Cob tip circumference in cms.	Cob weight in gms.	Length in cms.	Net weight shelled corn in gms.	Germination.	Planted row No.	YIELD. Pounds shelled corn.	YIELD. Bushels per acre.
401	193	109.0	18	36	13.5	9.5	8.8	6.0	20.0	15.3	89.0	100	501	7.94	39.05
403	40	72.0	20	32	13.1	11.5	9.0	6.8	17.0	14.4	55.0	96	503	9.19	45.20
412	64	94.0	16	36	13.3	10.6	8.7	6.6	20.0	17.4	74.0	96	507	10.63	52.28
417	138	140.0	18	37	13.9	10.3	8.3	5.1	23.0	18.8	117.0	96	515	11.31	55.62
421	173	135.0	20	41	13.8	12.1	8.5	5.5	22.0	17.5	113.0	100	529	10.75	52.87
433	222	133.0	16	36	14.8	10.5	10.4	5.7	26.0	15.7	107.0	100	522	10.50	51.64
439	34	141.0	16	38	13.6	10.0	9.0	6.5	25.0	18.8	116.0	92	528	10.44	51.34
442	36	140.0	20	33	14.3	9.8	9.5	6.2	26.5	16.5	113.5	100	516	10.06	49.48
445	199	72.5	16	30	12.4	10.5	8.0	6.5	11.0	13.0	61.5	100	511	8.94	43.97
446	193	99.0	22	31	15.0	11.5	10.8	7.0	21.5	14.6	77.5	100	506	9.75	47.95
448	193	128.0	18	35	13.8	11.7	8.8	6.3	22.0	16.5	106.0	92	532	8.69	42.74
454	6	103.5	18	35	13.3	10.9	7.9	6.4	18.5	16.3	85.0	100	548	7.00	34.43
455	113	73.5	20	24	13.9	12.8	9.5	7.7	15.5	11.4	58.0	100	538	9.38	46.13
457	113	157.0	16	42	14.6	11.0	10.0	6.5	30.5	19.2	126.5	96	514	9.88	48.59
461	138	90.0	18	33	13.8	11.4	9.0	6.3	18.0	13.9	72.0	100	508	10.88	53.51
465	162	122.0	16	39	13.8	11.0	9.0	6.6	24.5	15.8	97.5	100	535	11.44	56.26
485	204	73.5	16	36	12.6	10.6	8.3	5.9	15.5	15.7	58.0	100	512	11.06	54 39
*493	193	48.0	?	22	10.8	9.4	7.0	6.6	10.5	14.3	37.5	96	546	7.50	36.89
*499	168	78.5	14 ?	31	12.2	8.8	8.3	6.6	16.0	14.0	62.5	100	547	9.50	46.72
501	139	77.0	16	28	12.8	9.9	8.5	5.5	15.5	15.5	61.5	96	510	10.50	51.64
502	168	85.0	18	33	13.2	10.1	8.0	5.7	14.0	14.0	71.0	100	509	12.13	59.66
508	64	90.0	16	38	13.5	9.7	9.0	6.0	22.0	17.0	68.0	96	540	10.88	53.51
510	64	94.0	14	35	13.5	10.0	8.8	5.9	20.5	18.2	73.5	96	513	10.50	51.64
513	137	132.0	20	37	14.9	11.5	10.0	6.2	27.5	17.2	104.5	100	523	11.88	58.43
527	127	104.0	20	34	13.2	10.3	9.3	6.1	22.5	18.5	81.5	100	504	9.50	46.72
544	137	98.0	20	36	13.8	11.1	9.3	8.8	19.5	14.8	78.5	100	505	10.25	50.41
548	40	103.0	18	36	15.0	11.5	9.9	6.2	20.5	15.0	82.5	100	502	8.63	42.44
550	29	92.0	18	31	12.9	10.5	7.8	5.8	17.0	14.8	75.0	88	545	10.75	52.87
555	45	84.0	16	30	12.5	9.8	7.6	5.5	16.5	12.5	67.5	100	543	10.00	49.18
559	171	96.5	20	31	14.2	11.9	9.3	7.2	18.5	14.0	78.0	100	542	8.94	43.97
562	164	68.0	20	24	12.9	10.7	8.7	7.2	12.5	13.0	55.5	96	539	10.56	51.93
564	49	62.0	18	30	12.9	10.6	9.0	6.5	12.5	12.5	49.5	100	544	8.75	43.03
574	50	129.5	16	39	14.1	10.4	9.8	6.5	25.5	17.2	104.0	96	531	9.31	45.79
576	50	125.5	18	37	14.2	12.3	10.0	7.8	25.5	17.2	100.0	96	534	8.88	43.67
577	50	139.0	20	39	15.5	12.7	12.0	7.5	24.0	14.4	115.0	96	524	8.88	43.67
578	22	123.5	16	36	14.5	12.2	9.9	7.2	23.5	15.0	100.0	100	533	10.00	49.18
584	199	128.0	18	41	14.1	10.5	8.2	5.5	19.5	16.6	108.5	100	520	10.75	52.87
586	164	155.5	20	41	15.5	11.5	10.5	6.8	29.5	17.2	126.0	100	525	8.13	39.98
589	139	138.5	18	43	14.7	12.0	9.4	7·3	25.0	16.6	113.5	100	517	10.25	50.41
592	129	131.5	18	39	14.9	12.2	9.5	7.2	28.5	17.0	103.0	88	521	11.56	56.85
596	9	118.0	16	33	14.3	11.5	9.3	6.5	21.0	14.8	97.0	100	537	10.44	51.34
597	9	129.5	16	39	14.2	12.0	9.5	6.5	21.0	15.7	108.5	96	549	8.63	42.44
598	9	133.0	16	36	14.5	11.4	9.5	6.4	22.0	15.0	111.0	92	518	10.69	52.57
600	137	134.0	16	36	14.9	12.0	9.8	6.9	25.0	14.8	109.0	96	536	12.00	59.02
602	1	141.5	18	40	14.9	11.0	10.3	6.5	31.0	16.5	110.5	100	541	7.00	34.43
604	194	147.0	20	38	15.7	11.8	11.0	6.9	25.5	16.7	121.5	100	527	10.06	49.48
608	172	124.0	20	37	14.2	11·3	9.5	6.4	19.5	15.3	104.5	96	530	9.19	45.20
609	115	132.0	20	35	11.9	12.4	9.9	7.7	22.0	15.1	110.0	100	526	8.50	41.80
720	24	137.0	16	39	14.6	11.3	10.0	6.7	26.0	17.0	111.0	96	519	10.13	49.82
Means..		113.52	17.9	35.4	13.9	11.1	9.3	6.5	21.48	15.7	92.04	97.7	–	9.90	48.71

* These two ears were hand pollinated, and in consequence were not well filled. The data from these two ears are omitted from the averages given below.

By comparison of Table 1 (p. 259) (ears selected in 1907) and Table 5 (ears selected in 1908) a number of interesting points are brought out. It appears that, on the average, the ears selected as seed for 1909 planting were of higher quality in respect to practically all characters than the ears selected for planting in 1908. Thus the average weight of ear was about 18 grams more in the 1908 selections than in the 1907. There was an increase of nearly one-half row in the average number of rows in the 1908 selection as compared with 1907. The 1908 seed ears were on the average longer by about a half centimeter, had more kernels to the row, and a relatively smaller cob than the 1907 ears. In mean net weight of shelled corn to the ear the 1908 selections were about 17 grams higher.

In regard to quality in general, including shape of ear, filling of butt and tip, straightness of rows, fineness of grain, etc., the 1908 selections were as a whole, a very fine lot of ears. This is indicated by the illustrations of typical ears given in the plates farther on in the bulletin.

The yields of the rows in 1909 were in general at a higher rate than in 1908. The major portion, if not all, of this difference is due to the difference in the stand in the two years; one stalk to a hill in 1908, 2 in 1909.

There were two clear cut and striking general results of the test in 1909. The first of these was that the corn was again extremely early as compared with other sweet corn. It is very doubtful if any *gain* over the condition in regard to this character in 1908 was made. If it was it certainly could only have been slight in amount. But in any event all that was gained in 1908 was retained in 1909, making due allowance for differences in the two seasons. The following dates show the development of the corn in 1909. As has been said, it was planted May 20, 1909.

On June 19, 1909, the corn was found to be in good condition with fine even stand, no hills missing. Plants were from 12 to 18 inches high. On June 29, 1909, about one-third of the plants showed tassels starting. July 12, 1909, the field was well out in tassel. July 22 to 25 the silk was well out over the whole field. According to Mr. Arthur Tucker, superintendent of the Burnham and Morrill factory at Farmington, the entire three acres of corn was in the proper stage for canning on August

20-24, 1909. On August 29, 1909, Mr. Heath and one of the writers went through his two acres of corn in the attempt to find some ears suitable for boiling. After considerable searching a few ears were found but even these were already past the proper stage for eating. Owing to the location of the field on the low land along the Sandy river this corn was not injured by the severe frost of August 31, 1909. The corn was harvested for seed on September 15 and 16, 1909. It was thoroughly ripe at that time.

In connection with the farm distribution test (cf. pp. 284-292) of the Type I seed in 1909 the writers had an opportunity to see a great deal of the sweet corn grown in the State in that season. No corn was found which was as early as our piece at Farmington. Only a few pieces were seen which approached our corn in earliness. The best of these were in the vicinity of Rumford Center. This corn was about a week later than the Farmington field. On inquiry into the history of this corn it was found that the seed had been saved and selected for earliness for many years by Messrs. J. H. and F. D. Martin of Rumford Point. Further, during this time they had grown this corn on the same farm and under the same conditions so that it was completely adjusted to its immediate local environment.

Some idea of the earliness of the Farmington corn in 1909 as compared with other corn in the State may be gained from the statement that so far as the writers have been able to ascertain no corn was canned in the State before September 10, 1909. It seems safe to say that our corn was at least two weeks earlier than the earliest corn put up by the packers. It is worth pointing out that if all the corn in the State could have been as far along as the Farmington field it would have been safely out of the way before the killing frost of August 31, 1909. This frost did thousands of dollars worth of damage to the corn crop of the State.

The second point in which an improvement concurrent with the selection was noticeable in the 1909 corn was in regard to the conformation of the ear. Unfortunately it was not possible under the conditions of the work to take detailed data on this point in 1909, but there is no doubt that the proportion of good and fine quality seed ears was considerably higher in 1909 than in

1908. This may be taken to indicate the results of the first step in the process of weeding out undesirable lines (genotypes) in regard to ear characters.

The superior quality of the seed ears planted in 1909 over those in 1908 is brought out by the photographs of typical ears shown in Figs. 228-230, especially by comparison with Figs. 224-227.

In Fig. 228 the ears are so arranged on the plate that the rate of yield of the progeny of each ear in bushels per acre increases as we pass from the ear on the extreme left (No. 602) to the ear on the extreme right (No. 600). The first three ears at the left (Nos. 602, 586 and 609) gave rise to rows which yielded poorly. The other two ears (Nos. 592 and 600) produced high yielding rows. The data regarding each of the ears in Fig. 228, and their progeny are given in Table 6.

TABLE 6.

Data Regarding the Progeny of the Ears Shown in Figure 228.

Ear No.	Weight of shelled corn in grams.	Planted row No.	Bushels per acre.	Parent row No.	Bushels per acre of parent row.	Parent Ear No.
602	110.5	541	34.43	165	25.77	1
586	126.0	525	39.98	138	37.76	164
609	110.0	526	41.80	193	31.62	115
592	103.0	521	56.85	147	39.12	129
600	109.0	536	59.02	158	40.62	137

Similar data for the ears of Fig. 229 are given in Table 7, and for those of Fig. 230 in Table 8.

TABLE 7.

Data Regarding the Progeny of the Ears Shown in Figure 229.

Ear No.	Weight of shelled corn in grams	Planted row No.	Bushels per acre	Parent row No.	Bushels per acre of parent row	Parent ear No.
448	106.0	532	42.74	131	37.76	193
574	104.0	531	45.79	113	37.38	50
576	100.0	534	43.67	113	37.38	50
577	115.0	524	43.67	113	37.38	50
578	110.0	533	49.18	117	33.50	22

TABLE 8.

Data Regarding the Progeny of the Ears Shown in Figure 230.

Ear No.	Weight of shelled corn in grams	Planted row No.	Bushels per acre	Parent row No.	Bushels per acre of parent row.	Parent ear No.
417	117.0	515	55.62	103	40.00	138
589	113.5	517	50.41	146	45.50	139
596	97.0	537	51.34	149	52.62	149
597	108.5	549	42.44	149	52.62	149
598	111.0	518	52.57	149	52.62	149

Figure 229 shows 5 ears which produced rows yielding a little below the average for the whole test. It is to be contrasted with Fig. 230 which gives 5 ears producing rows above the average (with one exception introduced for another purpose). The pictures show clearly enough that there is certainly no marked difference in the average quality of these two sets of ears, as they would be judged by a person picking out ears from a miscellaneous lot for planting. Yet the average rate of yield per acre of the progeny of the 5 ears of Fig. 230 is 5.47 bushels more than that of the progeny of the 5 ears of Fig. 229. In other words, the ears of Fig. 230 yielded approximately 10 per cent. better than those of Fig. 229. There certainly is not a 10 per cent. difference in the quality of the ears themselves, as shown in the photographs.

Each of these figures brings out some further special points of interest. Thus in Fig. 229 the three ears No. 574, 576 and 577 are all daughter ears from ear No. 50 shown in Fig. 226. Ear No. 50 was the best individual of all those selected in 1907. Two of the three grand-daughter rows (534 and 524) yielded at exactly the same rate. The ear shown beside No. 50 in Fig. 226 is No. 193, an ear of good shape but very short and small as compared with No. 50. Now ear No. 448 in Fig 229 is a daughter ear from No. 193. Neither in size, shape nor quality is it noticeably inferior to the daughter ears from No. 50 (574, 576 and 577). Furthermore the grand-daughter row from ear No. 193 yielded at substantially the same rate as did the grand-daughter rows from ear No. 50. In other words, it appears that ear No. 193 was just as good an ear for planting purposes as was ear No. 50, though no one would ever have supposed so on seeing the two ears side by side.

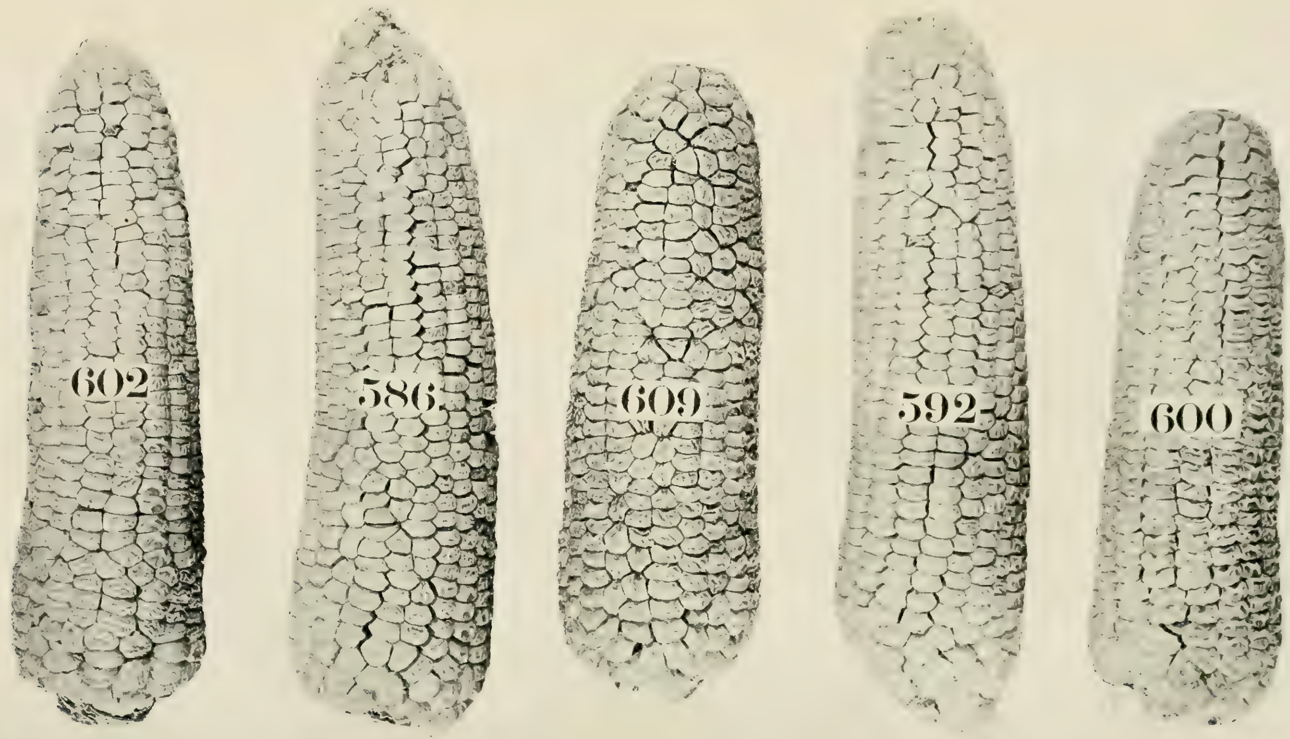

FIG. 228. Sweet corn ears selected in 1908 for planting in 1909.

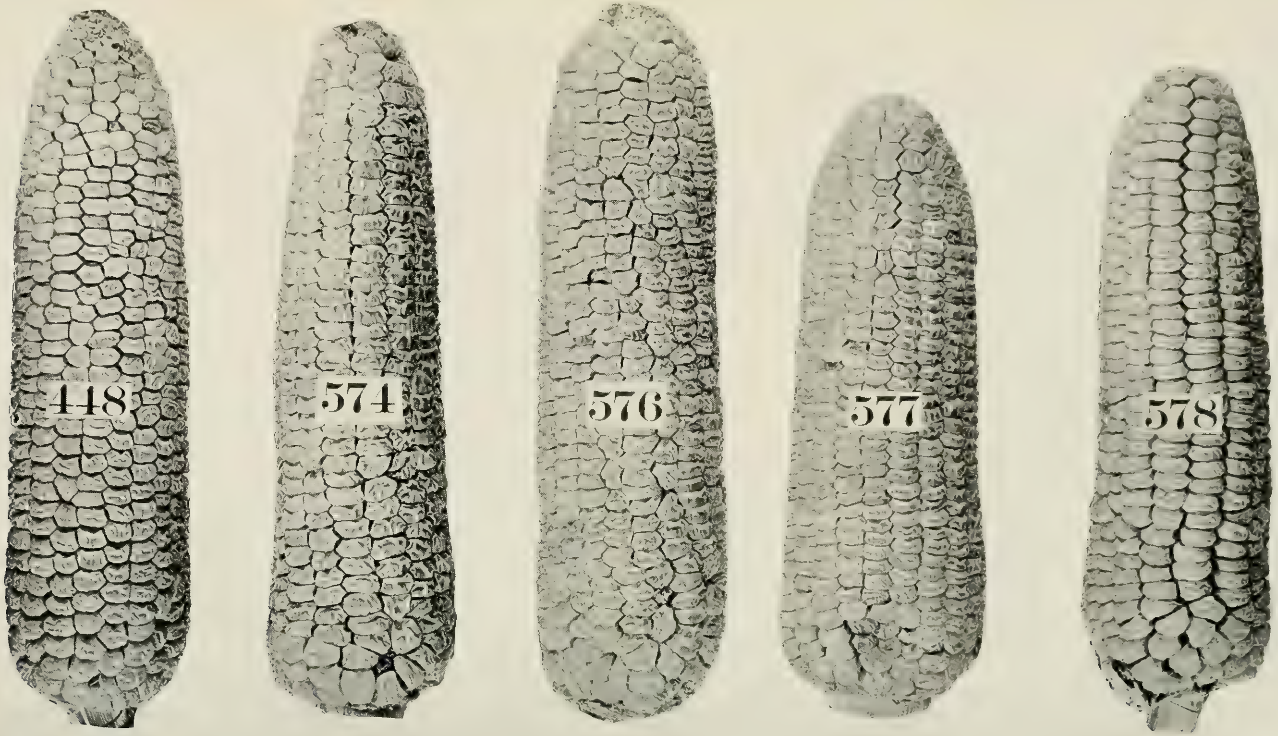

FIG. 229. Sweet corn ears selected in 1908 for planting in 1909.

Fig. 230. Sweet corn ears selected in 1908 for planting in 1909.

The same thing is brought out in a still more striking way so far as yield is concerned by comparing ear No. 578 with the 3 daughter ears from No. 50. Ear No. 578 is a daughter ear from the very poorly shaped, scrubby ear No. 22 shown in Fig. 227. Now while 578 is lacking in some particulars the high quality of Nos. 574, 576 and 577 yet after all it is a very good ear—far better than No. 22. But if we turn to the rate of yield of shelled corn to the acre it appears that the row from ear No. 578 (the grand-daughter row from ear No. 22) yielded nearly 10 per cent. better than any grand-daughter row from ear No. 50. In other words, suppose a farmer had been selecting ears for seed; the facts show that the outcome, so far as concerns the number of pounds of corn to be hauled to the factory, would have been better if ear No. 22 had been used to found a strain of seed rather than ear No. 50. Yet no one would ever think of using such an ear as No. 22 for planting if he could get anything better.

Such results as are here being discussed should not under any circumstances be taken to mean that the right thing to do when selecting seed is to pick out ears like No. 22, rather than those like No. 50. What the results do mean is that the external qualities of the ear, whether good or bad, are a very poor indication what that ear will do when planted. We have here simply another illustration of the old adage to the effect that it is not possible to tell how far a frog can jump by mere inspection of the frog. His jumping capacity is determined by innate, invisible qualities and characters, only to be tested by making him actually jump. In precisely the same way it is not possible to tell by the appearance of the ear how well relatively it is going to yield when planted. Because, just as with the frog, the yielding capacity depends on innate, invisible qualities. The only way to tell how it will yield is to plant it and see. If it then does yield well it *was* a good ear, even though it may not have looked the part.

All this means practically that in selecting corn for seed *the selection must be on the basis of the performance of the progeny (here the row) as distinct from individual ear selection.* The best ears to select for seed are those which came from good *rows.* A poor ear from a good row is vastly better than good ears from a poor row when the planting is on the ear-to-row

system. The average condition of a row (on the ear-to-row system of planting) is in some degree an index of the genotypic condition of the parent ear. Or, in other words, it is an indication of what it is worth as a breeder or propagator, as distinguished from what it is worth merely as an ear.

All this has its bearing on the current tendency to exploit fancy seed *ears* as such, of which we are seeing so much. The man who pays $250.00 for a single ear of seed corn (which by hypothesis he himself did not raise on some kind of a pedigree system) has a most extraordinary degree of faith in his ability to tell by the appearance of the ear what it will produce. He would do well to read and ponder over Mark Twain's tale of the jumping frog. It has a moral for every breeder, whether of plants or animals.

II. Farm Distribution Test.

In addition to the ear-to-row test in 1909 there was also carried on an extensive trial of this corn on a practical scale. This was done through a distribution of the seed to a number of farmers located in different parts of the corn growing sections of the State. As has already been noted, it was found that the Type I corn grown in the 1908 ear-to-row test was very early, as well as of fine quality. The question at once raised itself as to whether this marked earliness was anything fixed or inherent in the selected strains, or was merely the result of the favorable conditions of soil and cultivtion under which it was grown, combined with a high degree of adaptation or adjustment of the seed to those conditions. While on the Darwinian or "gradual accumulation" theory of selection it would be absurd to suppose that selection for one generation alone would bring about and fix such a marked improvement in earliness as was noted in the 1908 work, the "isolation" or "genotypic" concept of the action of selection would lead to no such difficulty. That is to say, on this latter interpretation a permanent (i. e., definitely fixed) improvement as great as that actually observed is a quite possible result of a single generation of selection. But, as a matter of fact, was the improvement in earliness obtained actually fixed? It is obviously impossible to answer this question definitely by continuing to grow the corn on the same experimental plots at Farmington. Because if (as was

the actual case) the improvement in earliness *is* retained there in successive generations it is quite impossible to be certain whether this is because it is inherited or because the corn is quite perfectly adjusted to the local conditions. In all breeding work with corn certainly, and probably with many, if not all, other crops as well, these two factors must be very carefully distinguished, or incorrect conclusions are almost certain to be drawn.

It, therefore, seemed desirable to test on a large scale what this selected seed would do under a wide variety of environmental conditions. By cooperation with the packers mentioned above (p. 255) a farm distribution test was made in 1909. Through their aid it was possible to get from one-half to 2 acres of corn from this seed grown by each of 47 farmers. The name and address of each of these farmers together with the acreage grown are given in Table 9.

It should be said that the acreages given in this table are not estimates, but were determined by actual accurate measurement of the plots. Taking all the cooperating planters together the average acreage in the test per planter was 0.95 acre, an insignificant fraction under one acre. The largest number (21), planted between 1 and 1½ acres. The next largest number (17) planted from ½ acre to 1 acre. Only 6 out of the 47 planted less than ½ acre, and only 3 more than 1½ acres. Of the latter only one (Mr. Heath) planted more than 2 acres.

The largest number of growers in any single county was in Oxford (15). Cumberland and Androscoggin counties each had 6; Franklin and Kennebec each 5; Penobscot 3; York, Somerset and Waldo each 2; and Knox 1. This distribution fairly well covered the corn growing region of the State (cf. fig. 231), and included a wide range of environmental conditions.

Table 9.

List of Farmers Cooperating in 1909 Farm Distribution Test.

Name.	Town	County.	Acres
A. H. Adams	Canton Point	Oxford	0.32
Josiah G. Adams	Wilton	Franklin	1.21
H. W. Allen	Strong	Franklin	1.54
E. U. Archibald	West Poland	Androscoggin	1.46
Andrew G. Arey	Cumberland	Cumberland	0.89
Frank P. Attwood	West Minot	Androscoggin	1.05
P. S. Bradeen	East Sumner	Oxford	0.96
Geo. B. Bradford	Turner Center	Androscoggin	0.85
R. O. Briggs	Buckfield	Oxford	1.01
William Briggs	Livermore Falls	Androscoggin	0.80
Chas A. Buck	Buckfield	Oxford	1.05
E. H. Burkett	Union	Knox	1.41
Fred H. Chandler	New Gloucester	Cumberland	0.91
H. M. Clements	Brooks	Waldo	0.99
A. D. Cummings	South Paris	Oxford	0.98
J. L. Damon	Buckfield	Oxford	1.00
J. A. Doughty	Oxford	Oxford	1.00
E. H. Eastman	West Buxton	York	1.01
E. W. Eaton	Dexter	Penobscot	1.45
Henry French*	Rumford Center	Oxford	0.22
J. F. Fuller & Son	South Paris	Oxford	1.01
H. M. Gage	Detroit	Somerset	1.08
J. H. Heath	Farmington	Franklin	2.02
W. A. Holt	Bethel	Oxford	0.97
J. W. Hunting	Welchville	Oxford	0.88
Geo. R. Kimball	North Bridgton	Cumberland	0.78
Edgar M. Lenfest	Manchester	Kennebec	1.39
J. H. and F. D. Martin*	Rumford Center	Oxford	0.10
M. W. Merrill	Lisbon Falls	Androscoggin	0.84
O. F. Merrill	Gardiner	Kennebec	1.16
Ephriam Moore	East Newport	Penobscot	0.61
H. J. Mosher	New Vineyard	Franklin	1.02
F. W. Osborn	Farmington	Franklin	0.19
Herbert Penley*	Rumford Center	Oxford	0.38
Franklin Pierce	Hebron	Oxford	0.96
H. J. Pullen	Dexter	Penobscot	1.14
Oren W. Ripley	South Montville	Waldo	1.11
Geo. Roberts	Harrison	Cumberland	1.09
F. L. Russell	Kents Hill	Kennebec	0.81
H. S. Talbot	Freeport	Cumberland	1.68
W. J. Thompson	South China	Kennebec	1.03
Granville Thurston*	Rumford Center	Oxford	0.31
T. D. Salley & Son	Madison	Somerset	0.83
C. E. Scammon	West Buxton	York	0.56
Dexter D. Storer	Readfield	Kennebec	1.08
Herbert N. Walton	North Leeds	Androscoggin	1.18
John R. Ward	New Gloucester	Cumberland	0.76
		Total	44.77

*These four fields were planted from the same lot of seed.

To each of the persons mentioned in the above table we wish to express our thanks for the aid which they rendered in carrying out this farm distribution test.

The geographical distribution of the corn growers in this test is shown graphically in Fig. 231 which gives (as solid dots) the location of each grower on an outline map of the State.

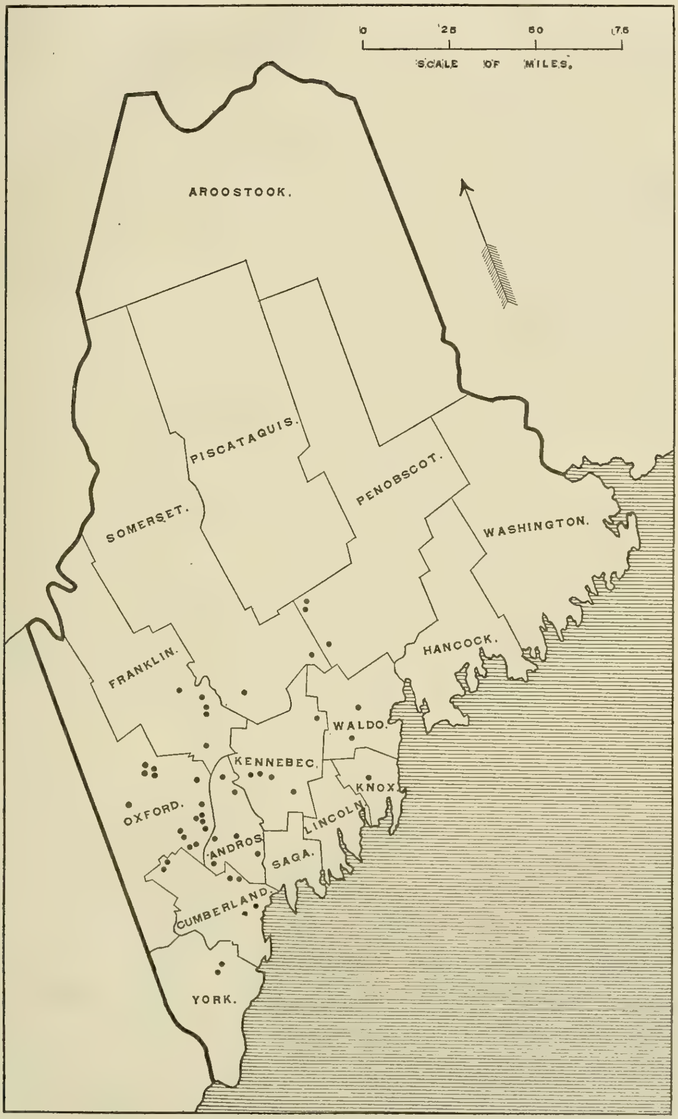

Fig. 231. Outline map of Maine with scale of miles showing by black dots the approximate location of each plot of corn grown in the 1909 farm distribution test.

The plan by which the seed was distributed to the growers was as follows: When the 1908 ear-to-row test plots were harvested the corn from each row was kept separate and sorted into A1 seed, good seed and nubbins (cf. p. 266). Taking all factors into account the 44 rows regarded as the best by us were selected for the farm distribution test. Then after rejecting the corn shelled from nubbins and ears too poor to go in as seed, the A1 seed and good seed from each of these 44 rows was put together in a bag. Each bag then contained the seed from one row of the 1908 ear-to-row tests, and the row in turn was grown from one single original mother ear of the 1907 crop. One such bag of seed was given to each farmer for planting, with strict instructions to avoid mixing this corn with any other. In other words, the farm distribution test was conducted in such a way as to make it the continuation of an ear-to-row test, on a larger scale. No special instructions were given as to planting, each farmer being told to plant, fertilize and cultivate the crop exactly as he would if he had ordinary factory seed.

Elaborate records were taken regarding each of these farm plots and the corn which grew on it. All but one of the plots were visited personally by one or both of the writers at least once, and in most cases twice, during the summer. It is neither possible nor desirable to present here all of the detailed data collected regarding these plots. All that can be attempted here is to give a summary statement of what appears to the writers to be the significant results of this experiment.

In such a statement the following points are to be noted:

1. The season of 1909 was, as has already been pointed out, a very unfavorable one for sweet corn growing, all over the State. The conditions, in other words, were such that the seed put out in this farm distribution test could not show its highest capabilities. This was quite generally recognized by the growers who planted it. A great many of the reports noted that the season was so poor that it was not felt that the seed had a "fair chance." Since, however, the purpose of the test was to compare the selected seed with the ordinary factory seed under the same conditions it is perhaps just as "fair" to make the test under generally unfavorable as under favorable conditions. The only difficulty was that some growers may

have been discouraged from giving the seed further trial in consequence of bad results not entirely, at least, the fault of the seed itself.

2. As was to be anticipated there was a wide variation in the outcome of the tests. In a few cases the plot from the selected seed was practically a total failure, not producing ears worth hauling to factory. In every such case of complete failure the fault was not with the seed, but with various other factors. The corn came up well, but was injured during the growing season. In one case the corn was nearly all killed by the drought and an exceptionally early frost accounted for the remainder. In two cases the corn was planted on such extremely poor soil, not properly fertilized or cultivated, that it could not make a satisfactory growth. At the other extreme were cases in which the corn was highly satisfactory in respect to all characters including earliness, yield and canning quality. Between these two extremes were all gradations.

3. There was practically entire uniformity in all reports that the seed of Type I which was distributed produced a corn of fine quality for canning purposes. That is to say, this selected seed produced ears of clear white color, good shape and size, and with small, deep and well packed kernels in nearly all the different environments in which it produced any crop at all. The uniformity of the reports in regard to this point is in striking contrast to the reports respecting the relative earliness of the corn.

4. In regard to relative earliness, there were great differences in different localities. In some cases the selected seed gave plots two weeks later than factory seed in the same locality. In other cases the selected seed was nearly, if not quite, as far ahead of factory seed. As has already been mentioned, Mr. Heath's plot at Farmington was very early. In a final report on his corn Mr. Briggs at Canton says regarding the earliness of his plot: "We judged it to be about one week earlier than the other (i. e. factory) seed." Mr. Doughty at West Poland found the selected seed earlier than the factory seed. In most cases the reports from the growers and our own observations show that the corn from selected seed was about the same as the factory seed in respect to earliness. The essential point appears to us to be that there is a great deal of variation in regard to the

relative degree of earliness of the corn when seed substantially uniform in respect to this quality is planted in different environments.

5. These results point clearly to the great importance in the production of sweet corn seed of the factor which has been called by Cook * "local adjustment." This investigator found that (*loc. cit.* p. 65): "The growing of a variety of cotton in a new locality is likely to bring about a distinct reduction in the yield as well as in the quality of the fiber. The deterioration has been found to be connected with an increase of diversity among the individual plants. Even when a carefully selected, uniform stock is used for the experiment a much greater amount of diversity may appear in a new place than when the same stock is grown under accustomed conditions of the previous locality where the variety was improved by selection." The results of the farm distribution test appear to us to indicate most strongly that essentially the same conditions obtain in sweet corn as in cotton as described by Cook. This is particularly true in regard to earliness and yield, less so in regard to the quality of the corn for canning purposes.

The importance of this factor of local adjustment in sweet corn may be shown by the citation of specific evidence in addition to the general facts already brought out. In the first place may be considered the cases where it was possible to compare the selected Type I corn in a new locality (environment) with another strain of seed well adjusted to that locality. In every such case which came to our notice in connection with the farm distribution test it was plainly the case that our selected seed did not do so well as the locally adjusted seed, even though the latter might be of a strain or variety really inferior to our Type I, when both were under such conditions as to give the best results. Thus, as mentioned before (cf. p. 280) Messrs. J. H. and F. D. Martin of Rumford Point have a strain of sweet corn which they have grown for seed for 20 years continuously. It is a good though somewhat coarse grained sweet corn but very well adjusted to local conditions. This is evidenced by its earliness, uniformity and yielding quality. A small plot of our Type I seed was planted by these gentlemen in 1909. It was almost a

* Cook, O. F., Local Adjustment of Cotton Varieties. U. S. Dept. Agr. Bur. Plant Ind. Bulletin 159, pp. 1-75, 1909.

complete failure. It was very uneven and irregular in its growth throughout the season. It showed the "diversity" which Cook emphasizes in the case of cotton in a new locality. It was much later than the Martin seed. This contrast between the locally adjusted and the newly imported seed was noted not only in the case of the corn on the Martin farm, but also in the case of two other plots in the same region (about Rumford).

The converse case to that just cited is illustrated by the condition at Farmington. There our Type I seed is locally well adjusted seed, whereas the factory seed is the imported. The superiority in all points of corn from our seed as grown at Farmington over corn from factory seed was beyond question, and admitted by all familiar with the corn in that region.

Another opportunity to observe the effect of this factor was given by the experiments with the Type II corn. The field selections of this corn in 1907 were made in Newport and Dexter. In 1908 the selected seed was planted at Farmington. The experimental plot of this corn was (a) much inferior to the Type I plot; (b) it was much more uneven and irregular in respect to all characters (i. e., showed greater "diversity" in the sense of Cook) than did the locally adjusted Type I on the one hand, or than the equally but differently locally adjusted Type II at Newport and Dexter on the other hand. These facts are readily interpreted on the local adjustment idea. One further point is of interest here. In the 1909 farm distribution test, plots of both Type I and Type II seed were planted at or near Newport and Dexter. While all did very well, the Type II seed clearly gave better results here than the Type I. Further the Type II seed gave much better results than it did the year before at Farmington. The suggestion at once comes to one's mind that these results are possibly due to the circumstance that the Type II seed in 1909 was brought back again in these cases to the locality to which it was "by nature" adjusted, whereas the Type I seed was here in a "new place." Such an interpretation, if true, would clear up at once the apparent paradox of a distinctly superior strain (as our Type I unquestionably is in general, as compared with Type II) giving worse results than an inferior strain under the *same* environmental conditions.

The point made by Cook that increased "diversity" very frequently follows the introduction of seed into a new locality finds

distinct and abundant confirmation in the results of the farm distribution test with corn. Specific instances of this have already been cited and need not be repeated. This fact is of great biological interest. The uniformity of well-adjusted corn, and the diversity of ill-adjusted, the "germ plasm," or hereditary constitution being alike in both cases, are equally remarkable.

It might be thought that one point which has been brought out in this discussion of the farm distribution test is opposed to the idea of local adjustment as a factor in breeding of seed corn. This point is that (cf. p. 289) in many cases the selected seed (Type I or II) when put into new localities gave as good or slightly better results than the factory seed. It might at first thought be supposed that the newly introduced seed ought always to give worse results than the other, if the local adjustment idea has weight. Such a conclusion, however, would not, in the writers' opinion, be justified. On the contrary it would appear that such cases as those mentioned merely mean that in those localities the farmers never have experienced and consequently do not know the valuable results which accrue from having seed from a locally well adjusted strain. In such cases the factory seed, as well as our seed, was, and is regularly brought in from some other locality. It is, in other words, just as "new" and on the whole possibly not so good as our selected seed. It is not then surprising that our seed did as well or better.

In general it may be said by way of summary that in the writers' opinion the farm distribution test justified itself many times over by showing so clearly the importance of the adjustment of the strains to local conditions as a factor in the production of seed sweet corn. When this point is realized by the packer and the farmer and intelligent account is taken of it in the growing of seed it will, we believe, lead to entirely different methods than those now followed. It is clear that it will be advantageous to practice such methods of production and selection as will tend to favor and increase local adjustment.

III. Plot Tests.

There were conducted at Farmington in 1909 some experiments to test certain particular points which had attracted attention in the course of the breeding work, and in regard to which it was necessary to have further evidence in order to interpret

the results of the breeding experiments. These tests were carried out on 1-6 acre plots on the intervale land of Mr. Heath's farm, adjoining the ear-to-row plot. Three experiments of this kind were tried, occupying altogether ½ acre of land. These experiments were as follows:

A. *The influence of the number of stalks to the hill upon the yield, quality and earliness of the corn.* In the course of our study of the sweet corn growing industry of the State we have found a very general tendency towards thick planting. The vast majority of farmers make it a regular practice to leave from 4 to 7 or even 8 stalks standing in the hill. The reason for this lies in the desire for stover for feeding purposes. Most farmers who grow sweet corn are also dairymen on a larger or smaller scale. They wish to get as much fodder from the sweet corn as possible. Consequently they plan to have a relatively large number of stalks to the hill. One hears very frequently the argument that since the shortness of the season is liable to cause a complete failure of the crop so far as ears are concerned it is wise to take measures to insure as much fodder as possible, so that some return may be had for the outlay of money and labor. Now a very slight acquaintance with corn teaches one that beyond a certain limit every increase in the number of stalks per hill means a decrease in the yield of ears. It, therefore, becomes a problem to determine where this limit is. Ears of sweet corn mean actual money to the grower. If he deliberately plants in such a way as to sacrifice in some degree yield of ears for yield of fodder it is desirable to know just what that fodder so gained is really costing him. Many farmers seem to proceed on the absurd assumption that in corn fodder they are getting something for nothing. As a matter of fact they often grow sweet corn fodder in such a way that it is probably the most expensive food they give their cattle.

Further, in 1908 the corn in our experimental plots was thinned to one stalk every 18 inches. This corn was earlier than anything we had seen in the State. The point at once arose as to whether part of this earliness might not be due to the amount of space allowed each plant, thus permitting it to make more rapid growth and hasten its maturity.

In order to gain some data regarding these points, a plot of land 144 feet by 50 feet was planted in the following way: the

rows were run the short way of the piece; in each row there were about 33 hills each 18 inches apart as in all our planting, the rows being 3 feet apart; beginning at one side of the piece the first 8 rows were planted with 2 kernels to the hill, the next 8 rows with 3 kernels to the hill, the next 8 rows with 4 kernels to the hill, the next 8 rows with 5 kernels to the hill, the next 8 rows with 6, and the last 8 rows with 7 kernels to the hill. The whole piece was evenly manured and fertilized, there being 150 lbs. of fertilizer put on the 1-6 acre. All the corn was cultivated in the same manner, and none of it was thinned. Every stalk that came was allowed to stand. The seed used was all from the same row (row No. 111) of the 1908 ear-to-row test. That is it all came from one original grandmother ear (ear No. 157). In other words all the conditions except the number of stalks to the hill were so far as possible made the same.

B. *The effect of heavy fertilizing on earliness of maturity.* The most successful sweet corn growers use relatively large amounts of commercial fertilizer in addition to heavy manuring. Where this is done it raises the question as to whether in many cases at least, the observed earliness of maturity which many of these more successful growers get is not primarily an environmental effect due to the abundance of plant food. It is conceivable that an abundance of fertilizer may accelerate the rate of growth, thus getting the corn to maturity earlier. To get some reliable data on this point the following experiment was tried. A piece of land 144 feet by 50 feet (= approximately 1-6 acre) was divided into two equal plots VIA and VIB. The soil was uniform over the whole plot. It was all given a heavy and even coat of manure. The rows were planted the short way of the piece, 3 feet apart and the hills 18 inches apart. The rate of planting was the same all over the piece, 4 kernels being planted to the hill, and the corn thinned to allow 3 stalks to stand in each hill. The same seed was used on both VI A and VI B. It all came from the same row of the 1908 ear-to-row test (row No. 153) and from the same grandmother ear (ear No. 64). The only difference between the plots was that when they were planted (May 20, 1909) 75 lbs. of fertilizer were put on VI A (being put in the hills, in the usual way), whereas no fertilizer whatever was put on VI B.

C. *An experiment regarding selection for earliness of maturity.* In the 1908 ear-to-row test the row which was by far the earliest in the plot was No. 131, and the row which was latest in maturing was No. 133. The differences between the two in this regard are indicated by the following notes:

CHARACTER.	ROW 131	ROW 133.
Tassels well out	July 9	July 15
Silks well out	July 20	July 27
Silks dry	August 3	August 12
First ears ready to harvest for mature seed	August 20	September 4
Ready for general harvest of mature seed ears	August 24	September 12

The seed from both rows was *fully matured* when harvested. This is an important point to be kept in mind in relation to the discussion of the results below.

In 1909 a piece of land 144 feet by 50 feet (= about 1-6 acre) was divided into two equal plots IV A and IV B. Both were treated in exactly the same way in preparation for planting and given an even coat of manure and the same amount of fertilizer (75 lbs. on *each* plot). The rows were as usual 3 feet apart and the hills 18 inches. The soil was of the same character over the whole piece. The corn was planted May 20, 1909, 4 kernels to the hill, and the corn was thinned to leave 3 stalks to the hill. Plot IV A was planted with a *random sample* of the seed harvested from the early row No. 131, and plot IV B with a *random sample* of the seed harvested from the late row No. 133. It is important to remember that the seed for IV A was *not* a *selection* from the earliest plants of row 131, and that for IV B was *not* a *selection* of the latest from row 133. In both cases the seed was a random sample.

RESULTS FROM EXPERIMENT A.

The corn in this experiment germinated well, and an even stand was obtained in each of the sub-plots. Of course every kernel planted did not come, but the average lag in number of *stalks* per hill behind number of *kernels* per hill was substantially the same over the whole piece. As the corn grew the plot as a whole presented a striking appearance. On the side where there were 7 kernels to the hill the growth of leaves was rank and luxurious. At the other extreme the corn had a very thin appearance, though what there was of it was thrifty enough.

The results of this experiment are shown in Table 10. In this table "green" refers to the condition of the corn when harvested for seed. Sweet corn thoroughly matured in the field contains between 50 and 60 per cent. of moisture as compared with its air dry condition.

TABLE 10.

Results of Experiment on Effect of Number of Stalks per Hill on the Yield.

Kernels per hill.	Good Seed Ears			Nubbins		Per cent of total weight of corn borne upon nubbins.
	Weight of green ears in pounds.	Calculated weight of dry ears in pounds *	Bushels per acre.**	Weight green in pounds.	Weight dry in pounds. *	
2	130.00	54.00	31.86	7.50	3.12	5.46
3	155.50	64.60	38.12	11.75	4.88	7.02
4	167.50	69.58	41.06	15.75	6.54	8.59
5	119.25	49.54	29.24	16.75	6.96	12.30
6	117.75	48.91	28.86	26.50	11.01	18.37
7	85.00	35.31	20.84	29.00	12.05	26.57

* Calculated from a shrinkage factor determined for this corn by weighing a definite amount of corn when harvested and again when thoroughly air dried. The value of this shrinkage factor for this sweet corn is 58.5 per cent. That is 100 lbs. of corn when harvested, will weigh 41.5 lbs. when air dry.

** Calculated in this and the following tables on the basis of 61 lbs. of air dried ears to the bushel.

The most important of the facts brought out by this table are shown graphically in Figs. 232 and 233.

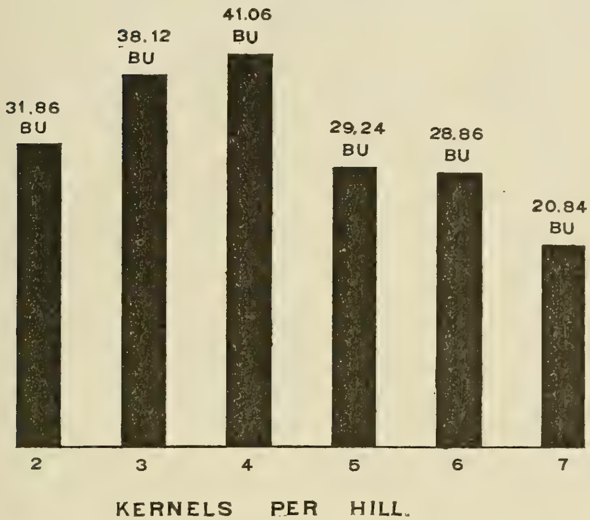

Fig. 232. Diagram showing the relative rate of yield in bushels per acre of sweet corn according to the number of kernels planted to the hill, without subsequent thinning.

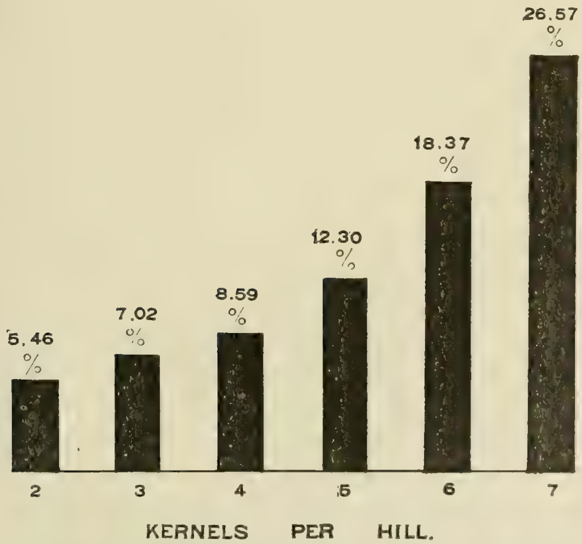

Fig. 233. Diagram showing the percentage weight of corn on nubbins in the total yield, according to the number of kernels planted to the hill, without subsequent thinning.

From this table and the diagrams we note the following points:

1. The highest yield of corn was obtained from the rows where 4 kernels were planted to the hill. Or, in other words, the largest amount of ear corn is obtained with an average stand of between 3 and 4 stalks to the hill. It is of interest to note that this is in agreement with certain results of this same kind of an experiment with field corn recently reported by Williams and Welton (*loc. cit.*).

2. With 3 kernels to the hill the rate of yield per acre is within 3 bushels of that with 4 kernels to the hill, and is nearly 10 bushels *higher* than with 5 kernels to the hill. Now 5 kernels to the hill in our plot meant an average stand of only a little over 4 stalks to the hill; and 3 kernels to the hill an average stand of about 2½ stalks to the hill. The present figures do not support the contention so frequently made in Maine that 4-5 *stalks* to the hill represent the ideal condition.

3. The rate of yield of ear corn in this experiment was actually higher when only 2 kernels were planted to the hill than when 5 or any higher number were planted. It must be remembered further that this was with seed of high germinating capacity and on the very best of corn land. If any land in the State can stand a high number of stalks to the hill it is that on which this experiment was carried out.

4. In this experiment there was practically no difference in yield between the rows planted with 5 and those with 6 kernels to the hill.

5. The rows planted with 7 kernels to the hill yielding at the rate of approximately 11 bushels to the acre less than those planted with 2 kernels to the hill.

6. The proportion of the total yield borne upon nubbins unfit for use for any purpose but feeding increases as the number of stalks to the hill increases. In the rows planted with 7 kernels to the hill more than 1-3 of the total yield was on nubbins. This matter of the quality of the ears produced is a very important one practically, especially if one is raising seed corn.

The general result of this experiment is quite clear and bears out the impression which the writers have gained from three years general study of the sweet corn growing industry in the

State. It is that even on the best of sweet corn land, heavily manured and fertilized, one can have a final average stand of more than 3 to 3½ stalks to the hill only at a heavy sacrifice in respect to yield of ear corn, when the hills are as close together as in this experiment. Of course it is impossible to make any general recommendation as to what is the best stand to have in any particular case. It depends on the character of the soil, the closeness of the hills together, the amount of fertilizer and manure used and still other factors. The important consideration is that he deludes himself who supposes that by planting 6 to 8 kernels to the hill, and thinning to 5 or 6 stalks (as many do) he is getting something for nothing in the fodder. He pays dearly for that fodder in the reduced yield and poor quality of his ear corn. We have yet to see any place in Maine where, under the usual conditions of planting and cultivation, the best results with sweet corn are to be obtained with an average stand of 4 or more stalks to the hill. There can be do doubt that many dollars are deliberately thrown away every year by the farmers of Maine by planting their sweet corn too thick. The farmer who wants fodder corn for his silo will do vastly better to plant a good strain of ensilage corn, than to try to get a good money return at the corn factory and fill his silo at the same time and off the same land. No American dairy farmer would think of using his cows both as milk producers and draft animals at the same time, yet many of them are trying to do what is essentially the very same kind of a thing with their sweet corn.

One of the chief objects of this experiment was to test the effect of the number of stalks per hill upon the earliness of the corn. As stated above (cf. p. 293) it was thought possible that the reason we obtained such marked improvement in earliness in 1908 was because each plant was allowed more space than is customary. The results of the present experiment make that conclusion unlikely. Notes regarding the earliness and other characters of these plots were taken every few weeks during the entire growing season. At no time was there any marked difference in the earliness of any of these plots. The plot with 7 kernels per hill and the one with 2 kernels per hill were ready for harvesting at practically the same time.

Results of Experiment B.

In this experiment, as was to be expected, the two plots VI A and VI B showed very marked differences throughout the season. The corn germinated well and evenly. A full stand was obtained on both plots. The corn in plot VI A grew faster and made more even and ranker growth than that in VI B. On June 19, 1909, the corn in the fertilized plot was about one-third larger than that in the plot without fertilizer. On July 12, the corn on the fertilized plot showed much ranker growth than that on the unfertilized plot. There was, however, very little difference in respect to earliness. About the same number of plants showed tassels in the one plot as in the other. During the latter part of the season the corn in the unfertilized plot grew better relatively than it did during the first half of the season. This was undoubtedly due to the manure which the plants were able to use about this time. When the corn was ready for harvest the plants in the unfertilized plot were about one foot shorter on the average than the rest of the field. There was practically no difference in the time of maturity. Both plots were ready for the factory and for seed at the same time. From this experiment it would seem that the amount of fertilizer has very little effect upon the time of maturity of this corn at least when grown under conditions to which it is locally well adjusted.

With regard to the yield, however, the case is different. Table 11 gives a summary of these two plots with respect to yield.

Table 11.

Results of Experiment on the Effect of Commercial Fertilizer on the Yield.

Plot No.	Good seed ears.			Nubbins.		Percent. of total weight of corn borne upon nubbins.
	Weight of green ears in pounds.	Calculated weight of dry ears in pounds.	Bushels per acre.	Weight of green corn in pounds.	Calculated weight of dry in pounds.	
VI A (Fertilizer)	565.75	235.01	46.23	98.00	40.71	14.25
VI B (No Fertilizer)	308.50	128.15	25.21	121.00	50.26	28.17
Difference	+257.25	+106.86	+21.02	—23.00	—8.55	—13.92

The following points may be briefly noted:

1. When commercial fertilizer was applied at the rate of 900 pounds per acre in addition to a good coating of manure the yield was increased 21 bushels per acre over the yield of the plot to which manure alone was applied. At the current price of $4.00 per bushel for sweet corn seed the return from the application of less than one-half ton of fertilizer would have been about $84.00.

2. When no fertilizer was used, corn grown on nubbins too poor for seed was about 14 per cent. more than in the fertilized plot. Further the quality of the seed ears from the unfertilized plot was inferior to that of the ears from the fertilized plot.

Results of Experiment C.

The corn in each of these plots germinated well and gave an excellent, even stand. The following brief extract from our notes on these plots will make clear their general course of development. On June 19, 1909, there was a good even stand with no hills missing. There was no observable difference between the plots in any respect. On July 12, 1909, there was no apparent difference as to earliness. Many plants in both plots were in tassel. There was, however, a difference in the general appearance of the corn. Plot IV A had a lighter color, narrower leaves and the growth was not so rank as in IV B. On August 28, 1909, plot IV B still showed a ranker growth and the ears appeared longer than those in plot IV A. The latter plot averaged to have more ears to the hill and the ears were of good shape, but rather short. In these particulars the plots resembled their parent rows (No. 131 and No. 133) of the previous season. At this time there was a *very slight* difference in earliness in favor of plot IV A. This difference was very small. It was not nearly so striking as it had been the year before between rows 131 and 133. This may be accounted for partly by the intermingling of the pollen from these two rows in 1908. But it does not seem probable that this had very much to do with it because the two plots showed such characteristic differences in other respects as in the manner of growth, width of leaves, etc. It is a very interesting fact that the selection of a random sample of seed from the earliest and

latest rows of the 1908 plot should produce only such a slight effect on the earliness in the next year's crop.

Many of our results seem to indicate that earliness, in a large part at least, is a physiological rather than an hereditary phenomenon. There seems to be no doubt but that corn once adapted to its local environment can be improved in regard to earliness by a rigid selection of the earliest plants for one or two years. After that it seems doubtful if any farther improvement can be made by selection for earliness, unless the corn becomes better adapted to local conditions. This matter will be tested farther and discussed more fully in a later publication.

Table 12 gives a summary of these two plots with respect to yield. It is very remarkable that these two plots should yield exactly the same amount of seed corn. Plot IV B had a slightly larger per cent. of its corn on nubbins but the difference is insignificant.

TABLE 12.

Yield of Plots Planted with Seed from an Early and a Late Row.

Plot No.	Good Seed Ears.			Nubbins.		Percent. of total weight of corn borne on nubbins.
	Weight of green ears in pounds.	Calculated weight of dry ears in pounds.	Bushels per acre.	Weight green in pounds.	Calculated weight dry in pounds.	
IV A (Early)....	386.50	160.55	31.58	75.50	31.36	16.34
IV B. (Late)	386.50	160.55	31.58	87.00	36.14	18.37

Summary and Discussion of Results.

This report deals with a portion of the results of experiments in breeding sweet corn extending over a period of three years. The more important of these results and the conclusions drawn from them may be summarily stated as follows:

1. Two types of corn were dealt with in the experiments. The history and characteristics of each of these are given. They are both white in color, and differ chiefly in regard to earliness of maturity and fineness and depth of kernel. The corn which is here designated as Type I is the superior variety in regard to these characters. It approaches closer to the ideal type of the corn packer than any corn grown in the State.

2. Both of these types have been subjected to selection in these experiments. The primary objects of the selection were to improve the corn in respect to (a) earliness of maturity, (b) yield, both of ears and stover, and (c) the general conformation of the ear, especially with reference to shape and to the covering of the tip with kernels. Earliness was regarded as the most important point.

3. The selection practiced was twofold. In the first place desirable *plants* were selected in the field and then the ears harvested from these plants were subjected to a further selection for size, conformation, etc.

4. A marked gain in earliness was observed after the first year's selection of the Type I corn. This gain was maintained in the subsequent year in the same locality where the corn had been grown in previous years. There is no evidence that there was any further gain in earliness following a second year's selection. This conclusion is still further borne out by the experience of 1910 involving a third year's selection. A three acre plot of Type I corn from seed selected for earliness is growing this year at Farmington and is, by a considerable amount, earlier than any other sweet corn in the region. Yet, making due allowance for differences in the seasons, it does not appear to be relatively earlier than was the selected corn in the ear-to-row tests in 1909 and 1908. In other words all the gain which has been made in earliness was accomplished in the first year's selection. No further increase has followed the further selection practised in the two subsequent years.

5. The Type II corn selected in 1907 was grown in a new locality (for it) in 1908. Under these circumstances no general gain in earliness was found, though there were individual rows which were distinctly early for that type of corn. The "new-place" effect appeared quite to outweigh the effect of selection so far as the general Type II crop in 1908 was concerned.

6. There was in general a marked improvement in respect to conformation of ear (including shape, fineness of kernel and quality of tip and butt) following the first year's selection. This gain has been maintained where the corn has been grown in localities to which it is well adjusted. A study of the sweet corn in the field in 1910 confirms this conclusion by another year's work.

7. Two years' ear-to-row tests furnish no evidence that there is any close association or correlation between the size or conformation of the seed ear and the *yield* of corn obtained from it upon planting. The large, well tipped, and beautifully shaped ear is as likely as not to prove a poor yielder when planted. This result means that the external, visible characters of the ear are a very unreliable indication of its probable worth for seed purposes. This is the same result to which all recent experimental studies of breeding appear to lead.

8. The present experiments point clearly to the conclusion that in any attempt to improve corn by selection the fundamental datum must be the performance of the *row* planted on the ear-to-row system (i. e., the performance of the *progeny* of an ear) rather than the individual ear or plant. In other words, the selection of the best *individual* cannot alone be depended upon for improvement. A poor genotype may often yield a good individual. The function of selection must be to discover and separate the desirable genotypes from the poor ones.

In making this statement it is not intended to advocate the isolation (whether by extreme pedigree selection or by hand pollination) of a *single* pure line or homozygote strain as the thing to be aimed at in practical corn breeding. Shull and East (cf. *infra*), who have isolated *pure* lines of maize, have both found that such corn yields very poorly and is altogether undesirable from the practical standpoint, lacking particularly in vigor. Apparently vigor and yielding quality in maize depend

to a large degree upon the maintenance of "broad breeding," i. e., of a heterozygous condition in the strain. From the practical standpoint it seems to us that the aim of corn breeding should be to get rid of poor genotypes and leave the good. There will under all ordinary conditions be enough of these latter to insure the heterozygote condition in the strain, particularly if, on the one hand, the all selected corn is planted on the ear-to-row system in a single plot and no detasseling is practiced, and, on the other hand, a deliberate attempt is not made in the selection to reduce to the lowest number possible the female lines involved in the pedigrees, as by taking the seed ears for a subsequent year's ear-to-row plot *all* from the *same* row of a plot planted on the same system, and keeping up this practice through several years. We are very much inclined to believe that in actual practice substantially as good results may be obtained by a general ear-to-row selection method, relaxed in intensity after a few years, as by the use of the more elaborate and costly "pure line method of corn breeding" of Shull. The latter method is probably right in principle, but the former method, in a much cruder and less precise way, really makes use of the same principle. Continued ear-to-row breeding (without too close pedigree selection) is continually testing out different heterozygote types and rejecting the undesirable ones. Presently a point will be reached where the great majority, if not all of the more strikingly undesirable genotypes (which when crossed produce the undesirable heterozygotes) will have been automatically eliminated. We shall then have reached by a much slower route the same goal which Shull attains quickly and directly by his "pure-line" method.

The rejection of undesirable genotypes can be most readily accomplished practically through the ear-to-row system of planting. Naturally one will never expect to get such rapid results following selection with an open fertilized plant like corn as with a self fertilized plant like the bean. One can not so quickly get rid of the influence of all poor genotypes.

9. Without wishing in any way to be dogmatic in the matter it appears to the writers that the results obtained in these selection experiments with corn indicate that inheritance in this form is fundamentally in accord with the "pure line" or genotype

idea of Johannsen with, of course, the limitations implied by the fact that it is an open fertilized plant. In so far these general results agree with the analytical studies of Shull and of East* having particularly to do with this point. We find the results of this experimental investigation to be very difficult (if not altogether incapable) of rational interpretation in accordance with the biological implications of the "law of ancestral inheritance."

10. The experiments, so far as they go, give no evidence that there is a cumulative effect of the selection of small fluctuating variations in sweet corn, though, of course, it is recognized that too short a period of time is covered to give any definite evidence on this point. It is believed (as already indicated in 8 and 9) that the observed favorable results which have followed selection in this work are to be explained as the result of the separation of a number of already existing genotypic lines possessing desirable qualities from the still more heterogeneous strains with which the work was begun. This is obviously, however, *in the present case* merely a matter of interpretation. It does not in any way influence the practical conclusion to be drawn from the empirical results, namely that if improvement does follow (as is the case) it is wise to practice selection.

11. A wide distribution of selected sweet corn seed over the State in 1908 demonstrated the importance of the factor of local adjustment (Cook) in the improvement of this crop by breeding. The good effect of selection may be quite obliterated as a result of planting the seed in a new locality. The emphasis which such results place upon the importance of (a) selecting for local adjustment, and (b) growing the seed in the locality in which it is to be used is obvious. During the summer of 1910, while this bulletin was passing through the press, a field trip was made by the writers covering a considerable part of the corn growing region of the State. The observations made in the present year confirm completely those made in connection with

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* Shull, G. H.—The Composition of a Field of Maize. Rept. American Breeders Assoc. Vol. IV., pp. 296-301, 1908. See also a further paper by the same author having the title "A Pure Line Method in Corn Breeding: *Loc. cit.* Vol. V., pp. 51-59, 1909.

East, E. M. The Distinction between Development and Heredity in Inbreeding. Amer. Nat., Vol. XLIII., No. 507, pp. 173-181, 1909.

the farm distribution test last year, in respect to this matter of local adjustment. In several localities where last year the Type I corn from the Station was nearly a complete failure, and much inferior to the facory seed, it is this year doing very well. The apparent loss of earliness and fine quality (due to "new place effect") is clearly seen not to have been a real loss at all, but merely an expression of lack of local adjustment. Thus it results that while in 1908 it was not possible to find anywhere in the State corn as early as the Type I at Farmington, such is not the case in 1910. Other plots of the Station Type I corn in other parts of the State where selection of a kind which amounted to selection for local adjustment was practiced last year, are this year nearly or quite as early as that at Farmington. Altogether our results clearly indicate that the local adjustment factor cannot be neglected in corn breeding work, whether one is concerned with practical results or scientific analysis.

12. Experimental plots designed to test the effect of commercial fertilizer, in addition to manure, upon yield and earliness showed an increased yield of 21 bushels of dry seed per acre in favor of the fertilized plot. On the fertilized plot there was less corn on nubbins and the remaining ears were of better quality. There was no effect on the earliness of maturity. Both plots were ready for harvest at the same time.

13. Random samples of seed from the earliest and from the latest rows in 1908 were planted in 1-6 acre plots in 1909. Both plots matured very early and at practically the same time. There was a very slight difference in favor of the seed from the earliest row. This difference was nothing approaching in amount what it might reasonably be expected to be if the piimary factor concerned in earliness of maturity in this plant were definitely inherited.

14. No attempt is made at present to discuss the biological basis of the improvement in earliness observed to follow selection for that character in these experiments. We are inclined to the belief that much, if not all, of this improvement is in reality a physiological rather than a genetic or hereditary phenomenon. The whole subject of breeding for earliness is one which needs more critical discussion and experimentation than has hitherto been given it.

On the basis of the experiments and observations reported in this bulletin, some practical suggestions regarding the growing of sweet corn in Maine have been prepared. In these suggestions there is outlined a simple plan of corn breeding which can readily be put into operation by any farmer or packer in the State.

The observations made by the writers during the four summers in which they have been in the field studying the sweet corn industry in the State have led to the conviction that there is both a great need and a great opportunity for seed improvement with this crop. The best interests of the farmer and the packer are in no conflict over this matter. The two great practical lessons which have grown clearer and more certain as the work has progressed are that to get the best results (from both packer's and farmer's standpoint) it is necessary first that definite *seed selection* be practiced to improve *earliness, yield* and *quality* of ear, and second that, notwithstanding a more or less widespread impression to the contrary, *locally grown and bred seed gives the best results,* provided, of course, that it is *well* grown and *well* bred. The best sweet corn in Maine today is grown from *locally* produced seed.

PRACTICAL SUGGESTIONS REGARDING THE GROWING OF SWEET CORN FOR PACKING AND FOR SEED.

The following pages contain some practical points regarding the raising of sweet corn in Maine which have grown out of three years work in (a) the experimental breeding of this crop, and (b) the observation of current farm practice and its results covering practically the whole of the sweet corn producing regions of the State. A complete report of this work, which forms the basis of these suggestions and *which should be read in connection with them,* is given in the foregoing sections of this bulletin. The evidence in support of the suggestions here made is to be found in that portion of the bulletin. It must of course be understood that these suggestions, like any others regarding practical farming, must be applied with common sense and due regard to local conditions as to soil, etc. The suggestions are grouped under three heads as follows: A. Growing Sweet Corn for the Factory. B. Growing Sweet Corn for Seed. C. The Care and Curing of Seed.

A. Growing Sweet Corn for the Factory.

1. *Plant early.* The growing season in Maine is short under the most favorable circumstances. Under present conditions the farmer must take chances at one end of the season or the other. Too often he plants in such a way as to take them at both ends. General observation shows beyond any question that the farmers who are most successful with sweet corn (i. e., who make the most money at the factory year in and year out) are those who plant relatively early. That is, they elect to take their chance at the beginning rather than the end of the growing season. At the worst they may have to plant a part of the piece over again. Whereas if the loss is by frost in the fall it is total and irreparable. Observation indicates that it should be a rule to plant as soon after May 15 as the soil is in condition.

2. *Use plenty of manure and high grade commercial fertilizer.* Too many farmers try to grow sweet corn without any or with too little commercial fertilizer. This is a suicidal policy under Maine conditions. 800 to 1000 pounds of fertilizer to the acre is not too much for most land on which sweet corn is grown in the State.

3. *Keep the corn clean from weeds and well cultivated.* The corn should be cultivated at least once a week until it is too tall to allow the horse to get through without breaking the leaves. It should be hoed by hand at least twice, and preferably three times. All cultivation must be shallow or the roots will be injured.

4. *Do not plant too thick.* Here is where a mistaken policy is most often followed. Experience shows clearly that when sweet corn is planted in rows three feet apart and with the hills 18 inches apart in the row, it is very unprofitable both as concerns the amount and quality of the ears, to allow more than 3, or at the very outside, 4 stalks to stand in the hill. 3 stalks to the hill is better than 4.

5. *Use seed well adjusted to the locality in which it is to be grown.* Extensive experiments and observation shows most clearly that the best results cannot be expected from seed produced in another locality and in a different environment from that in which it is to be planted. It is to the common interest of both the farmers and the packers to use not merely Maine grown but locally grown sweet corn seed. This seed should be selected for local adjustment (see below). The farmer, in his own interest, should avoid new kinds of seed which he has not found to give satisfactory results on his own or his neighbor's farm.

B. Growing Sweet Corn for Seed.

1. *Use home grown seed.* Experiment and observation indicate that it is to the best interest of the packer and the farmer that an arrangement be made whereby in connection with practically every factory enough seed shall be locally produced each year to supply the growers contributing to that factory. This will necessitate that, according to the size of the factory, from 2 to say 6 farmers shall, under the supervision of the packer

concerned, make a business of growing seed corn. The utmost care should be given to the selection of seed, looking towards the improvement of the strain. Suggestions regarding such selection follow. There is little doubt that it would be extremely advantageous from all points of view to have only one variety or strain of sweet corn grown in a locality. The gain in uniformity of product which would follow would be of great value to the packer. If not desired, however, there is no reason why the production of improved, selected seed should be confined to a single variety. The important thing is that, whatever the variety or varieties to be grown, the seed shall be locally produced.

2. *Plan for breeding improved seed sweet corn.* The following detailed plan is drawn up for the guidance of farmers and packers who desire to undertake the production of seed corn. It will, of course, be understood that business reasons make it imperative that the control of the sweet corn seed, if not the actual growing of it, be in the hands of the packers.

A. *First year's work. Field selections.* In the first year's work towards an improved strain of seed only the field selections of plants from which ears are later to be used for planting can be made. These selections should be made of the growing plants in the field. The fields from which seed is to be taken should be gone over at least two and preferably three times in making the selections. The first time may best be about the time the corn is ready for the factory or a little before. In choosing plants to be saved for seed look out for the following points in the order named. In going over the field one should provide himself with some strips of cheap bright colored cloth, about 2 feet long and 2 to 3 inches wide. When a stalk is selected to be saved for seed one of these cloths should be tied around it just below the tassel. This marks the plant so that it will be saved when the rest of the crop is cut.

1. *Earliness.* Whatever other good points a stalk may have do not save it for seed unless it is conspicuously earlier (i. e., more advanced in its growth) than the others around it This is most important.

2. *Size and vigor of plant.* Take only stocky plants with broad leaves, bearing good sized, and so far as can be judged at this stage, well shaped ears.

3. *Adjustment of plant.* Take only stalks which show the characters which are typical for the variety you are working with. Avoid freaks.

The field in which the selections are made must obviously be cut by hand, so that the marked plants may be left standing to mature their ears. As to the number of plants to be selected one must be governed by the extent of the proposed seed breeding operations. The only point to be observed here is to save about twice as many plants in the field as you expect to want ears for planting the breeding plot the next year. This is to allow for the subsequent ear selection in the winter.

When the selected plants are well matured (stalks and husks dead and drying) they should be harvested, and the ears should be husked and cared for in the manner described in the next section.

After the ears from these plants are well dried on the racks (say in December or January) the best of them should be picked out for shelling and planting. In selecting the ears for planting pay attention to the following points.

1. *Fineness of grain and maturity.* Take only ears having small, well packed grains in straight rows, and with the grains set firmly on the cob. Select no ears with fewer than 14 rows (better 16).

2. *Size and shape of ear.* Aim to select ears which are of medium size, nearly cylindrical in shape, and with butt and tip fairly well covered with grain. Do not reject an otherwise good ear because the tip is slightly defective.

3. *Germination.* Test the germination of each ear by taking 25 kernels from the middle of the ear and either placing them between two layers of wet blotting paper in a plate, or by placing them in a small box of wet sand. Keep the germination dishes or boxes in a warm room, and well moistened all the time. Reject all ears from which more than 2 kernels out of the 25 fail to germinate within 10 days. Our experience indicates that the germination of corn largely depends upon the way it is cured after harvesting (see below).

Having selected the ears for planting shell them, keeping the grain from each ear by itself in a paper bag. In shelling reject the kernels at the butt and tip, say for about ¾ inch back from

each end. At this stage, each ear finally selected for planting should be given a number. This number may be written on a slip of paper and put in the bag with the shelled seed.

B. *Second Year's Work. Breeding and Propagation Plots.* The corn should be planted each year in two plots, one the breeding plot and the other the propagation plot. In planting the corn for seed use the best corn land you have, and manure and fertilize it well. Plant the rows 3 feet apart and the hills 18 inches apart in the row. Plant 4 kernels to the hill and thin to leave the *two* best stalks standing in the hill. Give the plots the best cultivation you can.

1. *Breeding plot.* In this should be planted the selected ears. The planting here should be on the ear-to-row system That is, each selected ear should be planted in one row by itself. The row should be given the number borne by the ear which is planted in it. Careful observation should be made of the growth of each row throughout the season. Each row should be harvested separately at the end of the season, its yield determined, and the ears from it kept separate from the ears from all other rows.

The seed from the best *rows,* those showing greatest earliness and highest yield of good quality corn and stover, should be used to plant the propagation plot of the third year. In saving this seed reject all nubbins and poor ears.

The seed from the second best rows (i. e., those not selected for the propagation plot) may be distributed by the packer. This will be good seed, better adjusted than the ordinary factory seed to local conditions, but will not be the best.

2. *Propagation plot.* In the propagation plot of this year plant the good ears from the previous years selection which were *not* used in the breeding plot. They represent plants selected for earliness and local adjustment, and should be only second to the best, which were used in the breeding plot. It is desirable though not absolutely necessary in the propagation plot to detassel every alternate row. Detasseling is done by pulling out and throwing away the tassel (spindle) as soon as it appears, and before the male flowers which it bears have time to open and discharge their pollen. The ears from the detasseled rows are to be regarded as the best seed, and those from the rows where

the tassels were not removed as second best. The two classes should be harvested and cured separately. Seed from the detasseled rows will probably be found to yield better than that from the others.

3. *Individual plant selection.* Just as in the previous year the best individual plants from both the breeding and propagation plots should be marked with cloths and saved separately to furnish seed for the following year's ear-to-row breeding plot. If one desires he may breed a pedigree strain, by keeping the ears from the selected individual plants of a particular row separate by themselves. In this way the plants in such a strain will all be descendants of the same original mother ear.

C. *Third and succeeding year's work.* 1. *Breeding plot.* Plant on the ear-to-row system the individual ears selected in the previous year.

2. *Propagation plot.* Plant with seed from the best *rows* obtained in the *breeding plot* (ear-to-row) of the preceding year. In the propagation plot detassel every alternate row and distribute to the farmers the seed from the *detasseled rows* as *best* seed, and that from the rows not detasseled as second best seed (possibly at a slightly lower price).

3. *Individual plant selections.* Make these each year to furnish seed for the following year's breeding plot.

In suggesting this plan for improving the sweet corn seed used in the State the Station does not, of course, desire to force it on anybody. It must depend upon the foresightedness and progressiveness of the packer and farmer to decide whether it (or some similar plan having the same object in view) shall be adopted. It can only be said that no prediction can be more safely made than that the packer, and the farmers who grow corn for him, who will consistently follow the plan for a period of five years will be abundantly satisfied with the results in terms of dollars and cents at the end of the period. The advice of the Station Staff as to details in regard to breeding corn is, of course, always available to any packer or grower who desires to undertake such work.

C. The Care and Curing of Seed.

General experience indicates that the quality of a corn crop depends to a great extent on the way in which the seed from which it was raised was cured and cared for before planting. The following points are believed to be essential to the best results, and may be of help to the farmers of Maine.

1. *Harvesting.* Corn intended for seed must be fairly well matured, yet must not be chilled or frozen. The stage at which it may safely be harvested for seed is therefore an important point to know. In regard to this it may be said that corn may be harvested for seed as soon as the husks dry. However, the longer it can be *safely* left in the field after this the better it is. So far as germination alone is concerned the care after harvesting is relatively more important than the actual stage at harvesting, provided the kernels have begun to harden and glaze.

2. *Drying or curing.* As soon as possible after harvesting seed corn should be husked and the ears put in a *warm dry room* (temperature not lower than 50 degrees at any time) in which there is some circulation of air. To get the best results they should never be put in a cold shed or barn chamber, as is too often done. Seed corn is probably more often injured soon after harvesting by (a) chilling and (b) becoming alternately moistened and dried, than by any other causes. After drying is begun the corn should not be allowed to become moist, or even to stay in a moist atmosphere until it is planted. To get the best results it will be necessary to use some artificial heat (from a stove or furnace) in drying the corn. Any one engaged in the business of raising seed corn should have a special drying room.

3. *Storage during and after curing.* To get the best results with seed corn it is necessary that during the curing process and until the corn is shelled no ear should be in contact with anything but the surrounding air. In this way the air circulates around each kernel. The corn then does not mould and cures quickly and evenly. This condition can best be realized by the use of storage racks. The rack devised and used by the Station has the form shown in the following illustration. It has been found very satisfactory.

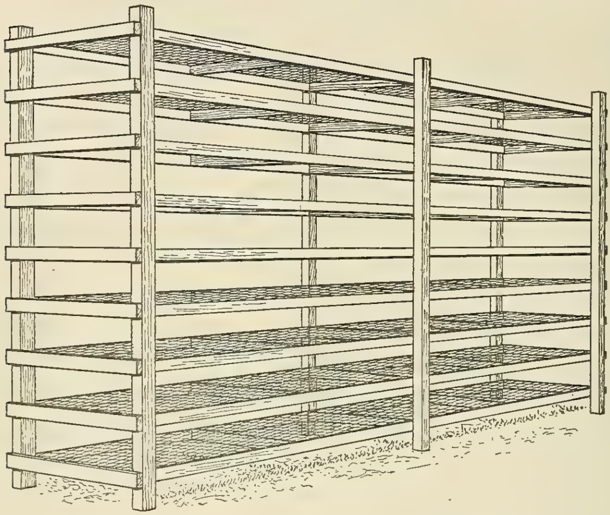

Fig. 234. Photograph of rack for drying seed sweet corn.

This rack is 12 feet long, 6 feet high and 2 feet wide. The uprights are of 2 inch x 3 inch stuff and side pieces 2 inches x 1 inch. The shelves are 8 inches apart. Over each shelf is stretched 2 foot wire poultry fencing of 2 inch mesh. The ears are laid on these shelves in such a way that no two ears touch each other. In this way only a few kernels of each ear rest upon the wires and the air can circulate freely through the whole rack.

The racks used by the Station and here illustrated are built with 9 shelves. They may, of course, be built with more or fewer than this number to suit particular conditions. It is not advisable, however, to make such racks much taller than those here described, because of inconvenience in reaching the corn on the shelves.

These racks may be readily converted into mouse and rat proof closets by covering them on sides, ends, top and bottom with wire fly screening. If this is done the screening on one side should be put on in the form of hinged doors.

BULLETIN No. 184

DIGESTION EXPERIMENTS WITH POULTRY.

J. M. Bartlett.

The digestibility of American feeding stuffs has been quite extensively studied in this country with ruminants, horses and hogs but as yet only a few experiments have been made with poultry. It is obvious that such studies are desirable on account of their practical importance and the growing demand for information in regard to the care and management of fowls which has come with the great increase in the poultry industry in recent years.

A few years ago the great bulk of the eggs and poultry which supplied our markets was produced by farmers, who let their hens run at large for the greater part of the year, picking up their living in the fields and pastures, supplimented perhaps by a feed of corn at night. But today when great plants are established, carrying thousands of birds, only the most careful and scientific methods of handling and feeding will make the business profitable. Several of the Experiment Stations have considered questions of poultry nutrition and much valuable information has been gained through feeding experiments for growth, egg production, etc., but the absence of definite standards and coefficients of digestibility of different foods for this class of animal has been a serious drawback to the best work. The abundant data available for other classes of farm animals might possibly be used to good advantage with poultry but the structure of the alimentary canal of birds is quite different from that of herbiverous animals, consequently the digestive capacity may be different.

The fact that the digested and undigested portions of the food are excreted together makes a serious obstacle in performing experiments with birds and greatly increases the amount of analytical work to be done. This probably in part accounts for the small amount of work that has been undertaken in this line. Another difficulty encountered is that fowls are less adaptable to general conditions of digestion experiments than other farm animals, owing to their activity and liability to depression of the normal metabolic processes that might result from being confined in cages without exercise. With all these obstacles in the way it is not surprising that but little digestion work with poultry has been undertaken. The only Experiment Station which has thus far published any results of this nature is the Oklahoma Station, Bulletin 46 by Fields and Ford. Four years later, in 1904, Bulletin No. 56, Bureau of Animal Industry, United States Department of Agriculture, by Dr. E. W. Brown, appeared giving the results of some experiments and a very complete review of the literature on the subject. According to Doctor Brown's review foreign investigators have given much more attention to this class of work than Americans. Two of these investigators, Lehmann and Paraschtschuk, employed an ingenious method of collecting the urine and feces separately by means of an artificial anus established in the body walls. This was brought about by means of an operation, cutting the intestine at a point just back of where the urine emptied into it, and bringing the end out to the body walls. The feces and urin were then collected separately in rubber bags. This method was considered in our work, and Dr. Raymond Pearl of the Biological Department of this Station operated on birds for the purpose. After a few trials a capon, No. 908, was very successfully operated on and made a good recovery but soon after being put on the experimental ration, which was at that time 7 parts corn meal to one part of beef scrap, his bowels became inactive and the feces had to be washed out at each collection. An experiment of several days duration was obtained, however, and is given in the tables, the feces number being 4470. The results compare quite favorably with the others obtained by the chemical separatory method, but the bird could not have been considered in normal condition. After a time the walls of the intestine be-

came weakened and rupture followed. As it did not seem possible that a bird under such abnormal physiological conditions could normally digest its food, further work by this method was abandoned and a method for collecting the feces under natural conditions taken up.

It was fully realized that a chance of considerable error might be introduced in any method that involved a chemical separation of the feces from the urine, but it was not thought practicable to prepare the number of birds by operation for artificial anus necessary to make all the experiments that were desirable even if it could be considered a more accurate procedure.

In the pages which follow an account of the experiments as carried out are given in detail. The composition of the foods and feces are given in Table No. 1. The weight of food and feces together with other data is shown in Table 2. The coefficients found for each feed and bird are given in Table 3. The average coefficients for each feed and mixture are given in Table 4. Table 5 contains the average coefficients of all feeding experiments available to the writer at the present time.

For the success of the experiments much credit is due to Mr. A. C. Whittier and Mr. J. F. Merrill, assistant chemists at the Station when the experiments were going on, who took the greater part of the care of the birds and performed all the analyses except most of the uric acid determinations which were made by the writer.

Method of Conducting the Experiments.

The first experiments undertaken were with year-old hens and were conducted principally to gain information as to the best methods to follow in the succeeding experiments. The work with the female birds was not very satisfactory. They were nervous, uneasy, and many of the experiments undertaken were not carried through on account of the bird getting out of condition. Only a few months during the winter could be given to the work, so but few experiments were performed in these preliminary trials.

For the next season it was planned to have enough capons provided to use for all the experiments but owing to adverse circumstances only about half the number required were ob-

tained, and to fill the deficiency cocks were used. These proved more satisfactory than the hens but were not so quiet and docile as the capons which seem to possess but one idea and that is to eat. For the next season an ample supply of capons was secured for all of the work.

For the accommodation of the birds two convenient rooms were provided, one being fitted with perches in the usual manner where they were kept during the resting periods and the other was furnished with tables on which the cages were kept. The cages in which the birds were confined during the experiment were made of boards for sides, top and bottom, with slats for the back and front. The bottoms were made tight, of matched lumber with base board across the slats to prevent anything being thrown out. The size of the cages was about two feet each way. For feeding and drinking dishes two pint dippers with handles were used for each cage. To hold the dipper in position the handle was passed through a slot in the side of the cage about 8 inches from the bottom and was held in place by a flat wedge outside. These dishes worked very satisfactorily and it was very seldom that any food was spilled from them. The time of the experiments was 12 to 14 days, being divided into two periods, a preliminary period of 5 to 7 days, when the amount the bird would eat was determined and the alimentary canal freed from other food, and a collection period, when the bags were put on and the feces collected. Clean shavings free from any material the birds would eat, were put in the bottom of the cages for the preliminary period, but during the collection period the bottom was kept clean in order to detect any loss of food or feces. No records of the weight of water drank was kept as it was known that the birds every time they dip their bills spill quite a portion of what they take up, therefore it would be impossible to tell how much was swallowed. A liberal amount of grit was supplied them at all times.

The feeding was done regularly at fixed hours morning and evening, and the feces collected at the same time, put in glass jars, and kept covered with alcohol to prevent fermentation. At the end of the collection period the feces were taken to the laboratory, the alcohol evaporated on the steam bath, then dried at 60 degrees C. to air dry condition.

Apparatus for Collecting the Feces.

Fowls are very sensitive and object seriously to any attachments, that interfere with their freedom of motion. The hens used were much more annoyed than the capons which, after a few vigorous efforts to free themselves, would calm down and submit quietly. The various devices used by other experimentors were studied and from suggestions gained thereby the following form which is shown in the cut on page 324 was devised and adopted. It was made of a rectangular piece of pure gum sheet rubber of sufficient size to make a tube 8 inches long and 3 inches in diameter. The edges were firmly cemented together and a ring was cemented to the top at an angle of about 30 degrees to keep the opening sufficiently distended and hold the bag in place. The lower end was closed by means of a screw clamp which could be readily taken off and allow the feces to be removed without removing the apparatus from the bird. It was held in place by 4 pieces of tape attached to the ring, the two upper pieces were carried up over the bird's back and joined just in front of his tail, then the ends were carried forward, passed under and around the wings and tied back of the neck. The two lower pieces were carried under the body, brought up in front of the wings and tied with the others back of the neck. Arranged in this way very little difficulty was experienced in keeping the bags in place and after a few hours wearing the birds appeared to be troubled very little by them. It was necessary, however, to use care in adjusting the straps; if drawn too tightly they were liable to chafe and if too loose the bag would not stay in place. The feces were removed through the opening at the bottom twice daily and at the end of the period any adhering particles were washed out with alcohol.

Methods of Analysis.

The foods used in the experiments were analyzed by the official methods given in Bulletin 107 (Revised), also the feces as far as possible, but in the case of the latter, as urine and solids are voided together, the amount of protein undigested could not be found by making the usual total nitrogen determination. In the urine of mammals the main portion of the nitrogen, representing the proteid digested, occurs in the form of urea and very little is present in the form of uric acid, while

in birds' urine the reverse condition is true and the larger part of the nitrogen present is in the form of uric acid. Therefore, in order to determine the amount of nitrogen which was present as undigested proteid it was necessary to determine the other forms separately. The ammonia was determined by the official method, namely distillation with MgO, but for uric acid there is no official method. Its estimation presents by far the most serious obstacle encountered in digestion experiments with poultry. On account of the presence of ammonia in the feces moisture was determined by drying several days over sulphuric acid in a partial vacuum.

Method for Determining Uric Acid.

After carefully considering all available methods for determining this acid the one worked out by Doctor Brown and given in Bulletin 56, United States Department of Agriculture, Bureau of Animal Industry, page 39, was given a trial. Our first attempts with this method were not very satisfactory. The filtration, after dissolving in piperidin solution, on paper was very tedious and in some cases impossible to carry through. Also in the case of some of the more highly colored feces so much coloring matter was left in the residue that titration could not be carried out. After a great many trials and many determinations by different modifications, the method which was finally adopted and by which most of the determinations were made is as follows:

Ten grams of the ground and thoroughly mixed feces were weighed into a 250 c. c. beaker and treated with 100 c. c. of 95 per cent alcohol filtered through paper and washed twice with 50 c. c. of alcohol, then washed 3 times with ether and allowed to dry. These treatments removed a greater part of the coloring and fatty matter. The residue when dry was returned to the beaker, 100 c. c. of a .5 per cent solution of HCl added and set in the refrigerator over night. The following morning the material was filtered through paper and washed twice with cold water, returned to the beaker with 100 c. c. of water and enough piperdine or sodium hydrate added to dissolve the uric acid. Piperdine was usually used as the solvent, as it seemed to dissolve the uric acid more quickly than a weak solution of sodium hydrate. A few drops of phenolphthalein were added

Fig. 235. Collection bag with straps.

Fig. 236. Collection bag attached.

to the solution in order to determine the amount of alkali necessary to dissolve all the uric acid, also the disappearance of the white particles which settle to the bottom of the beaker indicated complete solution. Usually it required one-half to three-fourths of an hour heating on the steam bath with frequent stirring to effect complete solution. After the white particles had all disappeared and the solution remained alkaline it was passed through a coarse linen filter into a 500 c. c. graduated flask, washed thoroughly with hot water, squeezing out the filter two or three times to facilitate washing, cooled, made up to the mark and thoroughly mixed. This solution was then allowed to settle until the fine particles which passed through the cloth had settled out leaving a clear solution which could be drawn off. It was planned to allow the flasks to settle over night and the solutions were found to be clear the next morning. Fifty c. c. portions, representing 2 grams of the feces, were taken, made acid with HCl, evaporated on steam bath to 25 c. c. and set in the refrigerator for 24 hours. Filtration was then carried out without difficulty through a 597 S. & S. filter paper on a Buckner's porcelain funnel 50 mm. in diameter, under pressure, washed 3 times with cold water, then with absolute alcohol and lastly 2 or 3 times with ether to remove any traces of fat remaining. The uric acid was thus collected on a very small filter paper which was transferred to a beaker, boiled with 35 c. c. of distilled water and titrated with either 1-10 normal piperidine or sodium hydrate. It was found necessary to complete the end reaction with the solution as near the boiling point as possible or concordant results could not be obtained. In all cases 3 portions of 50 c. c. were taken out for the determination. The first titration being made somewhat roughly to find the approximate end point. In carrying out the titration as the end point was being reached the beaker was again put over the flame and brought to the boiling point, then titrated to completion. To test the accuracy of the method pure uric acid was added to feces that contained none. The average of the determinations gave 98 per cent of the acid recovered.

The piperidine and soda solutions were standardized with uric acid which was purified by twice recrystallizing, and found to be practically pure. The writer found that 1-10 normal

NaOH could be used in place of the 1-10 normal piperidine and give practically the same results. Comparisons of several samples of feces were made using the two solutions with the following results:—

	Titration with NaOH	*Titration with Piperidine*
Sample No. 1.	11.5 per cent uric acid	11.6 per cent uric acid
Sample No. 2.	7.31 per cent uric acid	7.35 per cent uric acid
Sample No. 3.	10.85 per cent uric acid	10.80 per cent uric acid
Sample No. 4.	8.97 per cent uric acid	8.91 per cent uric acid
Sample No. 5.	9.98 per cent uric acid	9.92 per cent uric acid
Sample No. 6.	10.14 per cent uric acid	10.15 per cent uric acid
Sample No. 7.	10.15 per cent uric acid	10.18 per cent uric acid

Foods Experimented With.

Such feeds were selected as are most commonly used for poultry foods in this country. Probably no other one grain is so universally fed east of the Rocky Mountains as corn in some form or other and there seems to be no other grain so well relished by the birds. In some sections, particularly on the Pacific Coast, wheat largely replaces corn. In other sections oats and buckwheat or India wheat form an important part of the ration. In the mashes, particularly the dry mashes so-called, wheat bran forms an important part, often as much as 50 per cent, consequently this material was included in the test and several dry mash mixtures such as are usually fed.

Beef scraps. Best quality found in the market.
Bran, wheat. The coarses variety from spring wheat.
Corn, whole. No. 2 yellow, picked over and cleaned.
Corn, cracked. From No. 2 yellow, screened.
Corn meal. From No. 2 yellow corn.
Clover, cut. From second crop, just beginning to blossom.
India wheat. Fair quality, picked over and cleaned.
Oats. Best Western clipped oats, carefully picked over.
Oats, rolled. One of the best table varieties.
Wheat, hard. A variety of hard wheat sold as "hen wheat."
Wheat, soft. A seed wheat, rather soft, large, plump grain.
Dry mash mixtures:—

No. 1.
3000 grams bran
1125 grams corn meal
1125 grams gluten feed
600 grams beef scrap.

No. 2.	200	grams bran
	100	grams corn meal
	50	grams linseed meal
	40	grams beef scrap.
No. 3.	200	grams bran
	50	grams corn meal
	50	grams linseed meal
	100	grams gluten feed.

Mixture No. 3 was fed alone in one experiment and in another with about 7 per cent of bone ash to test the effect on digestibility of adding bone ash to a ration consisting of wholly vegetable matter.

CONCLUSIONS.

The results obtained in the experiments here presented indicate that the digestion coefficient of most nutrients for poultry are not materially different from other farm animals. Unlike ruminants, however, they digest very little crude fiber, hence a coarse fodder carrying much of this material is of but little value to them. The nutrients of wheat do not seem to be as well handled as most other concentrated grains, the ether extract showing a particularly low coefficient. Likewise bran, one of the wheat offals, shows low digestibility in organic matter, ether extract and nitrogen free extract. Its bulky and coarse condition has brought it much into favor to feed with more concentrated materials and it often makes as much as 50 per cent of the mixtures used for mashes.

The mixture of equal parts corn meal and fine cut early clover used in the experiments was sufficiently bulky to feed with concentrates, was more digestible and at present prices more economical providing, of course, the poultry man produces his own clover, which he should do. An exclusive diet of wheat had a deranging effect upon the digestive system of the birds.

Our results, like those of Brown and others, show that corn is a most valuable grain for poultry. Its palatibility and high digestibility has brought it into much favor with all poultrymen. It cannot, of course, be fed alone as it is too concentrated a feed and also deficient in protein, but when combined with feeds rich in protein and some bulky material as cut clover, it makes up a most desirable ration.

Oats and India wheat are desirable grains and may be used to some extent to give variety to the ration, but are much more expensive feeds than corn unless one is in a section of the country where they can be bought or produced much more cheaply than at the commercial centers.

The dry mash mixtures Nos. 1 and 2 have about the same digestibility and feeding value. Mixture No. 3 made up wholly of vegetable matter was not so well relished by the birds and gave slightly lower coefficients of digestibility, but the addition of about 7 per cent. of bone ash to the mixture increased the average digestion coefficient obtained with it but the differences were not greater than often occur between different birds on the same ration, so no definite conclusions can be drawn from the results.

Summary.

1. Corn shows a higher digestibility than any other grain tested.

2. Wheat bran shows a low digestibility and at present prices is not an economical feed.

3. A mixture of equal parts early, fine cut clover and corn meal is more digestible and a more economical feed than bran.

4. India wheat compares favorably with oats as a grain for fowls.

5. The ether extract of wheat has a low digestible coefficient.

6. Crude fiber was but very slightly digested and evidently is of but little use in a ration for poultry except to give bulkiness.

7. The mixing of about 7 per cent of bone ash with a ration consisting wholly of vegetable matter gave slightly higher average digestion coefficients than when the mixture was fed without it.

TABLE I.

Composition of Air Dry Foods and Feces.

	Station number.	Water.	Ash.	Protein.	Ammonia.	Uric acid.	Crude fiber.	Nitrogen free extract.	Ether extract.	Calories per gram.
Experiment with Bran, Wheat....	4447	8.22	6.67	15.25	–	–	8.42	57.56	3.88	4,090
Feces Capon, 108..................	4448	4.47	10.81	7.75	.47	6.24	12.68	53.35	4.23	3,938
Feces Cock, 152	4449	4.62	10.91	6.69	.56	6.98	12.23	54.00	4.01	3,893
Feces Capon, 168..................	4450	4.69	10.63	8.12	.68	6.20	12.37	53.08	4.23	3,923
Experiment with Whole Corn....	4427	5.57	1.35	9.35	–	–	1.59	77.51	4.60	4,099
Feces Hen, 717.	4433	5.45	24.59	13.94	1.44	9.80	10.38	31.27	2.82	3.165
Experiment with Cracked Corn..	4430	10.36	1.27	9.50	–	–	2.14	72.65	4.08	3,947
Feces Hen. 6.......................	4438	6.02	14.48	11.69	1.34	11.37	10.92	41.79	2.39	3.506
Feces Hen, 7.......................	4439	9.47	14.59	12.19	2.39	8.81	12.65	35.68	2.36	3.547
Experiment with Corn Meal......	4457	7.27	1.77	9.00	–	–	2.25	75.89	3.82	4.140
Feces Capon, 168..................	4461	4.65	7.82	12.25	1.19	8.53	12.59	50.80	2.17	3,853
Feces Cock, 84........	4462	4.24	7.87	10.55	.86	11.87	12.19	50.03	2.39	3.831
Experiment with Clover and Meal, 4457	4456	5.25	10.32	20.23	–	–	22.56	38.92	2.62	4,152
Feces Capon, 108....	4458	5.16	14.44	8.25	.22	6.30	21.50	42.06	2.07	3,706
Feces, 38	4459	4.96	13.76	8.69	.26	6.20	22.09	41.95	2.09	3,725
Feces, 168	4560	4.86	13.41	6.81	.26	6.47	21.33	44.82	2.04	3,731
Experiment with Meal (4457) and Beef Scrap	4463	4.84	23.02	48.69	–	–	–	–	18.71	4,618
Feces Capon, 108..................	4464	4.74	21.76	12.25	1.04	17.05	7.50	32.97	2.69	3.170
Feces Cock, 38	4465	3.47	19.83	9.56	1.35	20.30	7.76	35.69	2.04	3.194
Experiment with India Wheat....	4432	8.31	4.17	9.38	–	–	13.42	62.33	2.39	3.948
Feces Hen, 10.......................	4441	7.62	16.76	6.63	.95	5.05	30.76	31.01	1.22	3,292
Feces Hen, 12.......................	4442	6.77	21.36	6.13	.78	4.12	30.27	29.55	1.02	3.521
Feces Hen, 13.......................	4443	6.81	12.31	9.38	1.09	5.62	32.58	31.05	1.15	3,793
Experiment with Corn Meal, 7 parts and........................	4466	5.43	1.33	9.50	–	–	1.78	78.04	3.90	4.090
Beef Scrap, 1 part..................	4467	7.19	26.63	44.94	–	–	–	–	17.19	4.158
Feces Capon, 832..................	4468	5.27	18.05	14.00	1.61	16 20	9.29	32.55	3.03	3.110
Feces Capon, 835	4469	3.64	20.20	14.69	1.83	15.81	8.53	32.78	2.52	3.141
Feces Capon, 161..................	4471	5.17	16.21	10.00	1.68	18.30	10.21	34.11	4.42	3,255

Table 1.—Concluded.

	Station number.	Water.	Ash.	Protein.	Ammonia.	Uric acid.	Crude fiber.	Nitrogen free extract.	Ether Extract.	Calories per gram.
Feces Capon, 162	4472	5.26	23.48	11.31	1.71	14.48	10.58	30.20	2.98	2,943
Experiment with Oats Whole	4451	7.90	3.76	12.95	–	–	9.10	62.06	4.23	4,223
Feces Cock, 48	4452	4.02	17.52	6.06	.36	6.66	19.22	44.96	1.20	3,609
Feces Cock, 84	4453	4.27	15.78	6.06	.36	5.83	19.81	46.79	1.10	3,673
Feces Capon, 36	4454	4.61	13.08	7.62	.40	4.65	19.63	48.78	1.23	3,793
Feces Cock 38	4455	4.45	10.96	4.56	.45	6.39	20.45	51.49	1.30	3,906
Mixture No. 1	–	8.78	7.26	19.19	–	–	6.72	52.46	5.59	4,110
Feces Capon, 434	4478	5.71	12.50	6.00	.75	10.83	13.50	48.18	2.53	3,605
Feces Capon 832	4479	10.75	11.97	7.06	.68	8.95	11.37	46.59	2.63	3,481
Feces Capon, 835	4480	9.06	13.25	7.25	.71	9.95	12.21	44.73	2.84	3,473
Feces Capon, 162	4481	4.68	18.28	6.69	.67	10.14	13.03	44.77	1.74	3,378
Feces Capon, 163	4482	4.44	18.74	5.31	.52	10.00	13.09	45.93	1.97	3,428
Mixture No. 2	–	8.83	7.57	19.06	–	–	6.58	52.47	5.48	4,056
Feces Capon, 163	4483	4.19	14.10	8.31	.83	10.14	12.38	47.53	2.52	3,632
Feces Capon, Blank	4484	4.47	13.18	8.06	.96	9.60	12.98	48.91	1.84	3,663
Feces Capon, 162	4485	6.46	17.73	8.50	.91	9.90	11.97	42.42	2.14	3,437
Mixture No. 3	–	9.59	6.00	18.41	–	–	8.29	53.60	4.00	4,029
Feces Capon, 163	4497	4.37	16.55	7.44	.68	7.83	12.73	48.86	1.54	3,340
Feces Capon, 832	4498	4.65	15.37	5.86	.68	7.90	13.25	50.61	1.68	3,441
Feces Capon, 835	4499	4.40	15.92	6.28	.46	8.39	13.61	48.57	2.37	3,476
Mixture No. 3, with bone ash	–	–	–	–	–	–	–	–	–	–
Feces Capon, B	4501	4.64	22.18	5.06	.42	8.01	11.78	45.67	2.24	3,146
Feces Capon 1	4502	4.40	21.27	5.62	.57	7.60	12.02	47.13	1.39	3,131
Feces Capon, 434	4503	5.73	24.12	6.19	.42	8.29	11.18	42.12	1.95	3,043

TABLE 2.

Weight of Food and Feces and Other Data Relating to the Experiments.

Material fed and Station number.	Kind of bird.	Bird's number.	Station number feces.	Weight of air dry food eaten during collection period.	Weight of air dry feces excreted during collection period.	Weight of bird.	Weight lost during collection period.	Duration of experiment: Preliminary period.	Duration of experiment: Collection period.
				grams	grams				
Bran, wheat, (4447)............	Capon	108	4448	700	404	–	–	7	7
Bran, wheat, (4447)......	Cock .	152	4449	800	471	–	–	6	8
Bran, wheat, (4447)............	Capon	168	4450	800	469	–	–	6	8
Whole corn, (4427).............	Hen ..	717	4433	420	89.6	2246	71	7	7
Corn, cracked, (4430)..........	Hen ..	6	4438	420	96.0	–	–	7	7
Corn, cracked, (4430)..........	Hen ..	7	4439	420	90.0	–	–	7	7
Corn meal, (4457)..............	Capon	168	4461	600	123.5	–	–	7	6
Corn meal, (4457)..............	Cock .	84	4462	480	94.0	–	–	7	6
Meal, (4457) and...............	Capon	108	4458	480	253.8	–	–	7	6
Clover, (4456,) equal. parts....	Cock .	38	4459	600	313.0	–	–	7	6
	Capon	168	4460	600	295.0	–	–	7	6
Meal, (4457) and...............	Capon	108	4464	550	143	–	–		
Beef scraps, (4463,) equal parts	Cock .	38	4465	600	164	–	–	7	6
India wheat, (4432)............	Hen ..	10	4441	252	105	–	–	7	6
	Hen ..	12	4442	350	151.5	–	–	7	7
	Hen ..	13	4443	352.8	142	–	–	7	7
Corn meal, (4466,) 7 parts.....	Capon	832	4468	475	95.4	3256	24	6	6
and beef scrap, (4467) 1 part..	Capon	835	4469	480	132.6	3064	43	6	6
	Capon	908	4470	535	47.6	2330	gained 50	–	7
	Capon	161	4471	450	75.4	2605	50	7	6
	Capon	162	4472	450	70.0	4050	gained 5	7	6
Oats, whole, (4451)	Cock .	48	4452	300	14.0	–	–	6	3
Oats, whole, (4451)	Cock .	84	4453	480	219	–	–	6	6
Oats, whole, (4451)	Capon	36	4454	480	225.5	–	–	7	6
Oats, whole, (4451)	Cock .	38	4455	480	221.0	–	–	7	6
Oats, rolled, (4486)............	Capon	832	4487	250	49.8	3355	35	6	5

Table 2.—Concluded.

Material fed and Station number.	Kind of bird.	Bird's number.	Station number feces.	Weight of air dry food eaten during collection period.	Weight of air dry feces excreted during collection period.	Weight of bird.	Weight lost during collection period.	Duration of experiment	
								Preliminary period.	Collection period.
Oats, rolled, (4486)	Capon	1	4490	255	93.8	4340	130	6	5
And mixture No. 2	Capon	2	4491	138	53.6	–	–	6	5
	Capon	434	4492	297	99.6	3190	50	6	5
Wheat, 4428	Hen..	1	4434	420	119.0	2300	90	7	7
Mixture No. 1	Capon	434	4478	375	229.2	3250	10	7	6
Bran (4473) 3000 grams	Capon	832	4479	425	272.6	3210	gained 15	7	5
Corn meal (4474) 1125 grams	Capon	835	4480	450	291.0	3135	gained 30	7	5
Gluten meal (4476) 1125 grams.	Capon	162	4481	375	204.0	4450	65	7	5
Beef scrap (4475) 600 grams	Capon	163	4482	375	214.0	3324	35	7	5
Mixture No. 2									
Bran (4473) 200 grams	Capon	163	4483	375	218.4	3190	75	7	5
Corn meal (4474) 100 grams	Capon	–	4484	375	211.2	4465	65	7	5
Linseed meal (4477) 50. grams.	Capon	162	4485	375	200.0	4385	55	7	5
Beef scrap (4475) 40 grams									
Mixture No. 3									
Bran (4493) 200 grams	Capon	163	4497	200	148	3365	140	7	5
Corn meal (4494) 50 grams	Capon	832	4498	400	254	3130	20	7	5
Linseed meal (4496) 50 grams	Capon	835	4499	400	260.8	2900	25	7	5
Gluten feed (4495) 100 grams									
Mixture No. 3	Capon	–	4501	350	239	2445	55	7	5
With about 7%	Capon	1	4502	350	244.2	3875	45	7	5
Bone ash added	Capon	434	4503	290	207.8	2890	75	7	5
Wheat, No. (4429)	Hen..	3	4435	360	68.5	–	–	7	6
	Hen..	4	4436	300	86.0	–	–	7	6
	Hen..	5	4437	360	101.7	–	–	7	6
Wheat, (4444)	Cock	38	4445	600	122.5	–	–	7	6
	Cock	37	4446	600	120.0	–	–	7	6

TABLE 3.

Coefficients Obtained With Each Bird.

	Bird Employed.	Feces Number.	Organic Matter.	Crude Protein.	Crude Fiber.	Nitrogen Free Extract.	Ether Extract.	Calories Per cent.
Wheat bran (4447)	Capon 108	4448	47.1	72.3	13.1	46.2	37.06	46.8
	Cock 152	4449	46.8	74.2	13.6	45.7	38.4	46.8
	Capon 168	4450	46.3	68.8	13.9	46.0	35.4	46.2
Whole corn (4427)	Hen 717	4433	86.62	68.31	–	91.6	87.0	84.9
Cracked corn (4430)	Hen 6	4438	82.72	71.85	–	86.85	86.65	81.5
	Hen 7	4439	83.77	72.5	–	89.46	87.58	82.1
Corn meal (4457)..................	Capon 168	4461	82.4	72.00	–	84.0	88.3	82.0
	Cock 84	4462	83.8	77.1	–	87.9	86.9	83.4
Clover (4456) and corn meal....	Capon 108	4458	55.7	69.4	8.5	61.3	66.0	55.0
(4457) in equal parts.............	Cock 38	4459	55.7	69.0	7.2	61.9	66.1	55.3
	Capon 168	4460	57.9	77.1	15.5	61.7	68.8	57.9
Meal (4457) and beef scrap......	Capon 108	4464	82.5	89.0	–	77.3	93.8	79.2
(4463) equal parts................	Cock 38	4465	81.6	90.9	–	77.4	95.1	83.7
India wheat (4432)...............	Hen 10	4441	66.9	74.9	5.	79.3	78.8	66.4
	Hen 12	4442	75.9	79.5	29.1	85.5	86.6	62.7
	Hen 13	4443	75.1	70.6	28.6	85.4	85.9	62.9
7 parts corn meal (4466) and....	Capon 832	4468	86.8	79.9	–	90.1	10.0	86.2
Beef scrap (4467) 1 part..........	Capon 835	4469	81.6	70.9	–	86.8	87.5	81.9
	Capon 908	4470	94.1	85.7	–	96.3	93.4	–
	Capon 161	4471	89.0	87.8	–	91.6	86.7	88.6
	Capon 162	4472	90.5	87.4	–	93.2	91.7	90.3
Oats, whole (4451)...............	Cock 48	4452	62.1	78.1	1.5	66.0	82.2	62.2
	Cock 84	4453	61.9	78.5	–	65.6	89.3	62.1
	Capon 36	4454	58.9	72.3	1.9	63.1	84.5	59.2
	Cock 38	4455	59.4	83.7	–	61.8	87.0	59.1
Oats, rolled (4486)	Capon 832	4487	84.00	81.0	–	84.8	86.2	82.7

Table 3.—Concluded.

	Birds Employed.	Feces Number.	Organic Matter.	Crude Protein.	Crude Fiber.	Nitrogen Free Extract.	Ether Extract.	Calories Per cent.
Oats, rolled (4486) when fed......	Capon 1	4490	79.3	77.9	–	86.8	101.6	81.8
With equal parts.................	Capon 2	4491	95.4	70.9	–	102.8	91.8	71.6
Mixture No. 2..	Capon 434	4492	98.6	90.5	–	102.7	89.0	74.4
Wheat hard (4427)...............	Hen 1	4434	81.82	71 3	–	80.8	56.9	80.1
Wheat soft (4429)................	Hen 3	4435	85.36	71.66	17.14	90.3	60.2	82.2
	Hen 4	4436	82.22	57.02	–	89.6	68.6	79.2
	Hen 5	4437	80.55	69.82	–	87.0	50.6	76.1
Wheat soft (4444)................	Cock 38	4445	80.22	77.33	–	88.1	45.1	80.3
	Cock 87	4446	80.7	78.7	–	87.7	47.7	81.0
Mixture No. 1....................	Capon 434	4478	48.8	80.9	–	43.3	73.8	50.8
	Capon 832	4479	48.3	76.4	–	65.3	69.9	49.6
	Capon 835	4480	48.4	75.6	–	44.9	67.1	55.2
	Capon 162	4481	57.2	81.0	–	53.6	83.0	59.0
	Capon 163	4482	54.9	84.0	–	50.0	79.9	56.2
Mixture No. 2....................	Capon 163	4483	50.7	75.0	–	47.3	73.2	51.8
	Capon Blank	4484	51.7	76.2	–	47.5	81.1	52.8
	Capon 162	4485	51.8	74.6	–	45.2	81.1	58.4
Mixture No. 3....................	Capon 163	4497	35.4	70.1	–	32.6	71.5	30.2
	Capon 832	4498	46.2	79.8	–	39.9	73.3	50.5
	Capon 835	4499	45.2	77.7	–	40.9	61.3	47.8
Mixture No 3.....................	Capon Blank	4501	47.6	81.5	–	41.9	66.6	50.4
With bone ash....................	Capon 1	4502	45.3	78.7	–	38.7	75.7	49.4
	Capon 434	4503	47.8	75.8	–	43.7	64.1	50.0

In Table 4 below is given the average of all the digestion coefficients obtained on the different grains and mixtures experimented with. Comparing these figures with results obtained with other animals, it is interesting to note that they agree quite closely with those obtained with swine, as was noted by Lehmann. Also that coefficients of digestibility found for corn and wheat agree quite well with those obtained by Lehmann and Paraschutschuk who made use of an artificial anus to separate the urine from the solid feces.

TABLE 4.

Average of the Digestion Coefficients Obtained for the Foods.

	Number of experiments.	Organic Matter.	Protein.	Crude Fiber.	Nitrogen free extract.	Ether extract.	Calories.
Wheat bran (coarse)	3	46.7	71.7	13.5	46.0	37.0	46.6
Corn whole	1	86.6	68.3	–	91.6	87.0	84.9
Corn cracked	2	83.3	72.2	–	88.1	87.1	81.8
Corn meal	2	83.1	74.6	–	86.0	87.6	82.7
Corn meal and clover equal parts	3	56.4	71.5	10.4	61.6	66.9	56.1
Clover, calculated	3	27.7	70.6	10.4	14.3	35.5	–
Corn meal and beef scrap equal parts	2	82.1	90.0	–	75.8	95.0	81.5
Beef scrap, calculated	2	80.2	92.6	–	–	95.6	–
Corn meal (7 parts) beef scrap (1 part)	4	87.0	81.5	–	90.5	91.5	–
India wheat	3	72.7	75.0	20.9	83.4	83.8	64.0
Oats whole	4	60.6	78.2	–	64.1	85.6	60.6
Oats rolled	4	89.3	80.1	–	94.3	92.2	82.7
Wheat hard	1	81.8	71.3	–	80.8	56.9	80.1
Wheat soft	5	81.8	74.4	–	88.5	54.4	79.7
Mixture No. 1	5	51.3	78.6	–	51.4	74.8	54.1
Mixture No. 2	3	51.4	78.6	–	46.7	78.5	54.3
Mixture No. 3	3	42.3	75.8	–	37.8	68.7	42.6
Mixture No. 3 and bone ash	3	46.9	79.0	–	45.3	68.8	49.9

In Table 5 below are given the average coefficients obtained in all published digestion experiments with poultry known to the writer. The extremely low results given by Fields & Ford for protein in corn and peas are omitted from the averages. Aside from the results obtained at this Station figures were taken from the following authors and sources: Fields & Ford, Bulletin 46, Agricultural Experiment Station, Oklahoma. Brown. Bulletin 56, Bureau of Animal Industry, U. S. Department of Agriculture. Paraschutschuk. Journ. f. Landwirtsch. Berlin 50 J. Heft. 1, 9. Mai p. 15-32. 1902. Knieriem, Grost, Landwirtsch. Jahrb. Berlin, Bd. 29, Heft 3, 22. Juni p. 52-, 1900. Voltz, Lehmann, Kalugin. Landwirtschaftlighe Jahrbucher. Bd. 38, p. 553, 1909.

TABLE 5.

Average of Digestion Coefficients Obtained with Poultry to Date.

	Number of experiments.	Organic Matter.	Crude Protein.	Nitrogen free Extract.	Ether Extract.
Bran, wheat	3	46.70	71.70	46.00	37.00
Beef scrap	2	80.20	92.60	–	95.00
Beef, (lean meat)	2	87.65	90.20	–	86.30
Barley	3	77.17	77.32	85.09	67.86
Buck wheat	2	69.38	59.40	86.99	89.22
Corn, whole	16	86.87	81.58	91.32	88.11
Corn, cracked	2	83.30	72.20	88.10	87.60
Corn, meal	2	83.10	74.60	86.00	87.60
Clover	3	27.70	70.60	14.30	35.50
India wheat	3	72.70	75.00	83.40	83.80
Millet	2	–	62.40	98.39	85.71
Oats	13	62.69	71.31	90.10	87.89
Peas	3	77.07	87.00	84.80	80.01
Wheat,	10	82.26	75.05	87.04	53.00
Rye	2	79.20	66.90	86.70	22.60
Potatoes	6	78.33	46.94	84.46	–

BULLETIN No. 185.

MAINE APPLE DISEASES.

W. J. Morse and C. E. Lewis.

Introduction.

While Maine is well to the north of the apple-growing section of the United States, there is no settled part of the State where at least some varieties of eating apples cannot be grown successfully. Even in northern Aroostook in the latitude of Quebec certain of the Russian varieties, and some of the more hardy apples of American origin, are grown to perfection and are of a quality unexcelled. Moreover these varieties are perfectly hardy there, sometimes withstanding temperatures of —40 degrees F. and below. During the winter of 1906-7, when southern Maine and certain other parts of New England and adjacent portions of Canada suffered great loss from winter killing of apple trees, practically no damage was observed in Aroostook County.

Fortunately or unfortunately, as it might be regarded from one point of view, climatic and soil conditions are such in Maine that a fair crop of good apples can be produced usually with a minimum of care and attention. In too many instances in years gone by the owner has not felt the necessity of giving his orchard any attention after setting the trees other than to harvest the grass which grows therein and to pick an occasional crop of apples which may be produced; cultivation, if any, being secondary as a result of growing some annual crop in the rows between the trees. The fact that a considerable number of trees would survive this treatment, producing fair returns for the labor involved, has in the past materially helped to delay the general adoption of more approved systems of orchard management.

Competition with apples produced farther West, which command a higher price simply on account of more attractive appearance and packing, has resulted in rapidly increased attention to and adoption of better methods of orchard management. In every case where these improved methods have been introduced, the results have far exceeded expectations. At the same time there has been within the last few years a combined and united effort among the various agencies in the State which are concerned in the furtherance and betterment of the agricultural and horticultural interests to bring about the production of more and better fruit in Maine. As a result of these various factors working together, the old let-alone methods of orcharding are rapidly passing. Old orchards are being trimmed and renovated and orchard cultivation and spraying are yearly receiving more attention. Not only are the old orchards receiving better care, but probably more new trees have been set in 1910 than in any other single year in the history of orcharding in the State.

With increased attention to the welfare of the trees, the owners are becoming aware of the fact, as never before, that there are various diseases which impair the health of the tree by attacking the trunk, limbs and leaves, which also are detrimental to the appearance and keeping qualities of the fruit. Therefore, in response to many inquiries addressed to the Station for information along this line, it has seemed best to prepare a somewhat comprehensive publication upon the nature and treatment of Maine apple diseases. While, as far as possible, the results of studies and investigations made at this Station are made the basis of the recommendations given, the published reports of work in other parts of the country have been freely drawn upon where necessary.

Published data with regard to the nature and extent of Maine apple diseases is rather meager. Therefore it is hoped that in addition to providing descriptions and giving methods for the control of the more common diseases which interest the orchardist that this publication will be of some value in extending the known range of the various diseases of the apple and in a measure give some idea of their prevalence and distribution in the State. With this end in view some few diseases, particularly some of the apple decays, which are either new or little

known in America, but which have been found in Maine, have been mentioned and briefly described. As a rule these are not of much economic importance in the State. Similarly a description of some diseases, like the bitter rot of the fruit, which occur to a slight extent in the State have been included because these are of great economic importance in other parts of the country. These latter may or may not become factors in Maine orcharding, but it seems desirable that all apple growers become familiar with their characters.

Character and Causes of Apple Diseases.

If we accept a rather broad definition that disease in plants includes the effect of every unfavorable factor entering into the life of the plant it follows that various agencies of the living and non-living environment may be responsible for the condition known as disease. While it is not always easy or convenient to discuss the disease apart from the cause, it should be kept clearly in mind that the parasite or other exciting factor is not the disease. The latter is the condition induced in the host as the result of the presence of the former, rendering the plant partly or wholly incapable of responding to its environment. Therefore all methods of disease control should be based upon an as extended and as detailed knowledge as possible of the responsible factor or factors regardless of their nature, but it is important as well to be able to recognize the outward manifestations or signs of the disease upon the host to aid in its identification. The outward manifestations of plant diseases are frequently not apparent until too late to remove the cause and save the plant or fruit. Hence from their character and mode of attack preventative measures must be largely relied upon to prevent losses from plant diseases, particularly those which attack the apple.

Those diseases which are induced by unfavorable soil and climatic conditions or other non-living agencies are said to be *non-parasitic*. Those which result from the attacks of various forms of organic life upon the host or from their presence within its tissues are classified as *parasitic* diseases.

This bulletin is concerned with certain non-parasitic diseases and those parasitic diseases of apple trees and fruit in Maine which are produced by fungi and bacteria. For a detailed dis-

cussion of the various insect parasites of Maine orchards and the means by which they may be controlled the reader is referred to a circular recently published by this Station on the Apple Tree Insects of Maine.

In this State fungi are responsible for the major part of the loss from the diseases under consideration. Fungi are low forms of plant life made up of threads of microscopic size. These threads constitute the *mycelium* of the fungus, which penetrates into the tissues of the host, causing the death of the cells which compose these tissues and living upon their contents. The conspicuous portions of the fungus which are seen on the surface of the host are in most cases the fruiting organs. Instead of seeds these fruiting organs produce various forms and in various ways, often in vast numbers, more simple bodies which are known as *spores*.

In combatting apple diseases caused by fungi, the chief object is to prevent the formation of these spores, or if they are formed to destroy them before they can germinate and gain a foothold upon healthy fruit, foliage, or wood. This is more frequently brought about by destroying the diseased portions as soon as observed and by coating or spraying the healthy parts with some substance which will prevent the germination and destroy the spores if by chance they fall thereon.

The threads of many fungi are colorless, while others are more or less colored or darkened, but all are devoid of the green coloring matter which enables the higher plants to manufacture their food substances, through the aid of energy obtained from sunlight, from the simpler compounds which they get from the air, soil and water. Hence fungi and bacteria which are also deficient in green coloring matter must depend upon more complex organic bodies to supply their food materials. Through the action of various ferments which they produce, parasitic fungi can break down and destroy, with varying degrees of ability, the tissues of their host plants. The results of this decomposition furnish them the food materials necessary for their maintenance and growth. The threads of a wood destroying fungus may be penetrating deep into the interior tissues of an apple tree, causing their death and decay with very little evidence of disease upon the surface. In fact the conspicuous, external symptoms do not as a rule appear till the fungus has

used up considerable of the available food material and throws out fruiting organs on the surface.

Those fungi and bacteria which are able to attack living bodies are said to be *parasitic* or *parasites*. Those which secure their nourishment from dead organic matter are designated as *saprophytic* or *saprophytes*. The saprophytes far outnumber the parasites and the majority of them cannot under any condition cause disease. However, there is no hard and fast line between the two classes. Some fungi which ordinarily live as saprophytes may, under favorable conditions, attack and destroy living plant tissues. Some fungi are obligate parasites but a large number of the disease producing forms are capable of a saprophytic mode of existence as is shown by the fact that they may be successfully grown upon a variety of artificial culture media. This fact is of great importance to the orchardist. Dead limbs, piles of rubbish and rotted fruit which frequently are allowed to accumulate in the orchard are breeding centers for those fungi which attack the fruit, leaves, and wood of the tree. Hence the first step in removing the cause of disease is thorough orchard sanitation.

Non-parasitic Diseases.

Winter Injury. Those parts of Europe and Asia where the apple is native have very moderate rainfall and are not subject to such wide range and abrupt changes of temperature as in this State. The northern limit of range of the apple except in the case of the very hardy varieties is determined approximately by the lowest winter temperatures, or —30° to —32° F., repeated at frequent intervals. Some varieties, like the Baldwin and Ben Davis, in Maine apparently are liable to be injured where the repeated minimum winter temperatures are several degrees warmer than this.

Other conditions also enter into winter killing, such as deficient rainfall in spring and early summer followed by a late fall, thus preventing early growth, maturity and ripening of the season's wood. Similarly too, late cultivation and the application of large amounts of fertilizer rich in nitrogen may also stimulate to late growth and prevent ripening of the wood before cold weather comes on, and predispose to winter injury. The amount of moisture which the plant cells contain at the time

the low temperatures are experienced is also a contributing factor. The more water they contain, beyond certain limits, the more likely will they be injured by freezing. This probably accounts for the fact that very frequently in Maine the trees in the more exposed locations have suffered less from winter killing than those in more sheltered situations. There was better drainage, the ground frozen more deeply and the roots chilled and inactive and not supplying water to the plant tissues above.

The severe winter killing of 1906-7 was probably due to the combined influence of low temperatures alternating with high and a large percentage of water in the tissues of the trees. Weather conditions of January, 1907, were particularly favorable to this as will be seen by examination of Fig. 237 which shows within a week a record of —40° F. and —35° F. with two warm days having a maximum temperature of +45° F. and +47° F. situated midway between. Moreover it will be seen that the changes from extreme cold to thawing and back to cold again were quite abrupt, particularly in the case of the latter. Winter killing of trees may occur, however, as the result of a deficiency of moisture in the soil associated with continued cold, dry winds in winter.

Much of the danger from winter killing can be avoided by planting only those varieties which have been found to be perfectly hardy in a given locality. Only the most hardy varieties should be planted in those parts of the State where the minimum winter temperature frequently reaches or approximately reaches —30° F. The planting of Baldwins and possibly Ben Davis as large commercial ventures should be restricted to those parts of the State where the minimum winter temperature, repeated at frequent intervals, seldom reaches below —20° F. or at the utmost —25° F. The location of the orchard may have much to do with hardiness. Low, heavy or wet soils should be avoided,—it was orchards in such locations which suffered most in the severe winter killing of 1906-7. Those which were located on more or less sloping land with good air drainage, with plenty of natural or artificial soil drainage as a rule suffered much less from winter injury.

There is considerable difference of opinion among Maine orchardists with regard to the value of wind-breaks. A very good illustration of the good they may do was furnished by an Orono orchard following the severe winter just referred to.

This orchard was badly injured, particularly on the north and northwest sides of the more exposed trees and in the direction from which come the prevailing cold winds of winter. A natural wind-break of evergreens and coppice growth was situated so as to protect a portion of the trees and here the injury was much reduced or absent altogether.

Aside from the possible value of planting wind-breaks very little can be done to prevent winter injury in orchards already planted except to provide artificial drainage where necessary and to avoid forcing the trees to too luxuriant and late growth during the latter part of the season, as has already been mentioned. However, much of the ill effects following an adverse winter may be eliminated by proper attention to the injured trees. Observations made in Maine orchards for 4 seasons following the winter injury of 1906-07 have convinced the writers that as much if not more damage has occurred indirectly from the attacks of fungi following the winter injury and which gained entrance through the wounds thus made than as a direct result of the winter injury itself. In many cases very little was done to remove the injured parts and they were allowed to decay and serve as breeding places for wood destroying fungi. Later this decay followed back along the injured limbs or into the interior of the trunks, resulting in the death of the entire tree.

While severe pruning and cutting back immediately following winter injury is not advocated, all dead wood should be cut out as fast as seen and the wounds at once covered with a good liquid grafting wax or two or more coats of pure white lead in boiled linseed oil, and then repainted as frequently as necessary to keep the wounds well coated till they are covered with the new growth.* The dead bark on trunk and crotch injured areas should be removed back to healthy tissue and the wood thus exposed kept well covered with grafting wax or pure

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*In some instances severe injury to the trees has been reported where the entire trunks have been heavily coated with lead and oil, to prevent insect attacks. This may be due, however, to the use of impure lead and either unboiled oil or some substitute for linseed oil. In the writers' experience, and so far as can be learned, the use of pure white lead in boiled linseed oil has been universally successful in treating wounds made in pruning.

white lead and boiled linseed oil. Bridge grafting may be used where collar freezing occurs.

Crotch injury. Associated with the winter killing of 1906-07 many of the injured trees showed the bark killed in the crotches as illustrated in Fig. 238. A similar trouble was observed in Ontario and other parts of Canada. There is some difference of opinion as to just how this crotch injury was produced, but there is no reason for regarding it other than as one form of winter injury. This should not be confused with a similar trouble caused by the pear blight bacillus which has been described by Whetzel in New York.

Frost bands on fruit. Occasionally late frosts occur which are not sufficient to destroy the young fruit, but do result in a peculiar characteristic russeting. As the apple enlarges and approaches maturity this appears in the form of a band of varying width extending entirely around the fruit midway between the stem and calyx.

Frost injury of the leaves. Very frequently associated with frost bands on the fruit there is more or less injury on the foliage. This has been described by Stewart and Eustace as follows: *

"On the upper surface the leaves were variously wrinkled and puckered, but the under surface was fairly even and normal in appearance except for certain areas on which the color was gray green. On some trees the leaves were badly distorted with the margins drawn downward and together as if they were unable to unfold properly. Usually the wrinkles were most abundant along the mid-rib of the leaf and the elevated portions were of a somewhat lighter green than the other parts of the leaf. By cutting across the leaf with scissors it was found that where the wrinkles occur the lower epidermis is separated from the green, pulpy tissue (mesophyll), thus forming a large interior cavity or blister. The distance between the green tissue and the loosened epidermis was frequently as much as four millimeters (one-sixth of an inch), and the blisters thus formed were of all sizes up to those having an area of 100 square millimeters or even more. In many cases the separated epidermis became ruptured as if slit with a knife, leaving the cells of the

* Stewart, F. C. and Eustace, H. F. N. Y. Expt. Sta. Bul. 220, p. 218. 1902.

mesophyll exposed. Sometimes the tender cells thus exposed died, causing the formation of an irregular, dead, brown spot, visible on both surfaces of the leaf. However, in the majority of cases the exposed cells remained green throughout the season."

They ascribe this to a frost occurring about the 10th of May, and the appearance of the trouble first came to their attention about June 1. They state that in 1902 this condition was general throughout New York except in the Hudson Valley and on Long Island. A similar condition has appeared in Maine but no such general occurrence has been observed by the writers. This curling of the leaves as the result of early frosts should not be confused with that caused by apple scab, aphids or plant lice.*

*Protecting orchards from frost.*** The apple crop in Maine, as in many other parts of the country, is often materially reduced and in some sections may amount to a total failure as the result of frosts occurring at blossoming time or when the fruit is small. From time to time the question of starting fires and smudges in the orchards on cold nights to ward off the frost has been agitated, but the practicability of this has remained more or less of an open question. Recent work in the far West indicates that it is entirely possible, under some conditions at least, to prevent the destruction of the crop in this way at relatively small expense. Interested parties are advised to write to the Secretary of Agriculture, Washington, D. C., for the free Farmers' Bulletin 401 which tells how this work is done.

Mr. P. J. O'Gara, the author of this bulletin, says: "The results of the past season's work in the Rogue River Valley have shown that many acres of crops valued at from $500 to $1,000 per acre have been saved at a total expenditure of not more than $15 to $20 per acre for firing. Very striking examples have been seen where unsmudged orchards adjoining those that have been smudged have borne no fruit."

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* See pp. 16 and 17 of the Circular on Apple Tree Insects of Maine, already referred to on p. 340.

** For many practical suggestions with accounts of successful commercial tests in several states in protecting orchards from frost at blossoming time the reader is referred to the special "Orchard Heating Number" of Better Fruit. Vol. V, No. 4, October, 1910.

Russeting or spray injury of fruit. Bordeaux mixture, some of the prepared brands of lime-sulphur, and to a less extent home-cooked and self-boiled lime sulphur spray, may produce a russeting of the fruit.** The relative merits of lime-sulphur and bordeaux mixture as a spray for apple trees will be discussed elsewhere in this publication.

Experience at other places and at this Station has shown that bordeaux mixture is more likely to produce spray injury than most of the lime-sulphur sprays now on the market. Bordeaux injury first appears as small, regular, black or brown spots scattered over the apple, but more frequently on those parts which received the most spray. These spots differ from those caused by the apple scab fungus in that they are more regular and are not sunken. As the apple grows these spots are replaced by russeted blotches. In severe cases the fruit may become distorted, irregular and sometimes cracked. Fig. 239 represents the later stages of bordeaux injury on the fruit.

The following list prepared by Hedrick classifies apples according to their immunity to bordeaux injury.†

"1. *No injury or very slight.*—Alexander,* Akin, Bietigheimer, Bloomfield, Baxter, Canada Baldwin, Doctor, Doctor Walker, Deacon Jones, Domine, Early Harvest, Esopus *Spitzenburg,* Fall Pippin, Fall Wine, Fishkill, Florence, Gano, Golden Russet, Judson, Keswick, Northern Spy, Oliver, Perry, Pomme Grise, Ralls, Red Canada, Richard Early Winter, Rome, Roxbury, Rutledge, Smokehouse, Stump, Swaar, Titovka,* Tompkins King, Yellow Bellflower.

"2. *Slight injury.*—Buckingham, Chenango, Clayton, Elgin Pippin, Fallawater, Fameuse, Fanny, Gideon, Grimes, Haas, Holland Winter, Hubbardston, Jewett, Karabovka,* Lady, Lady Sweet, Landsberg, Louise, McIntosh, McMahon, Maiden Blush, Monroe Sweet, Munson, Oldenburg,* Ontario, Pewaukee, Primate, Prince Albert, Pumpkin Sweet, Red Astrachan,* Reinette Pippin, Saint Lawrence, Shannon, Stanard, Stark, Sutton, Te-

** For an account of spraying experiments conducted in 1910 with a discussion of the spray injury from lime-sulphur and bordeaux mixture the reader is referred to a forthcoming bulletin of this Station by Mr. W. W. Bonns, the Station Horticulturist.

† Hedrick, U. P. N. Y. Expt. Sta. Bul. 287, p. 142, 1907.

* Russian varieties.

tofsky,* Tolman *Sweet,* Tufts, Wallace Howard, Washington Strawberry, Western Beauty, Williams, Wolf River, York Imperial. Crabapples—Excelsior, Montreal Beauty.

"3. *Badly injured.*—Autumn Streaked,* Barry, Belborodooskoe,* Ben Davis, Borsdorf,* Boskoop, Canada Reinette, Constantine,* Cooper Market, Czar Thorn,* Ewalt, Flory, Golden Sweet, Gravenstein, Hurlbut, Jeffris, Jersey Sweet, Kalkidon,* Lankford, Late Duchess,* Longfield,* Milden, Milwaukee, Monmouth, Mother, Nero, Newman, Northwestern *Greening,* Ostrakoff,* Paragon, Parry White, Peck *Pleasant,* Peter, Rambo, Red June, Scott, Smith Cider, Sops of Wine, Switzer,* Wagener Improved, Walbridge, Washington Royal, Wealthy, White Pippin, Windsor, Winesap, Workaroe,* Yellow Newtown, Yellow Transparent.* Crabapples—Chicago, Coral, Hyslop, Martha, Paul Imperial, September, Transcendent, Whitney.

"4. *Very badly injured.*—Baldwin, Collamer, Jonathan, Mann, Red Transparent,* Repka,* Rhode Island *Greening,* Romna,* Saint Peter,* Twenty Ounce, Vineuse Rouge,* Winter Banana, Wagener, Yellow Calville.*"

Much of the injury from bordeaux mixture may be avoided if proper attention is given certain factors which have more or less to do with its occurrence. Too strong bordeaux should not be applied—a 3-3-50 mixture is recommended. The lime should be of good quality and approximately equal parts of lime and copper sulphate should be used. Never pour concentrated solutions together—equal and full dilution of the milk of lime and copper solutions should be made before mixing. Cover the fruit and foliage with a fine mist, but do not apply sufficient mixture to cause the trees to drip. Do not spray during rainy, foggy or damp weather. Study susceptibility of varieties. Those varieties which are listed above as badly or very badly injured by bordeaux mixture, and any others which the orchardist's experience indicates should be placed in this class, should not be sprayed with bordeaux mixture after the leaves begin to unfold. Past experience has shown that under Maine conditions with those varieties like the Ben Davis which are quite susceptible to spray injury, the ill effects resulting from the application of bordeaux mixture, except early in the season, have equalled or exceeded the good. As is indicated elsewhere

* Russian varieties.

in this publication (p. 378) there is considerable reason to believe that some form of the lime-sulphur sprays in proper dilution may be of service on such varieties. Bulletin 135 of the Illinois Station by Prof. Chas. S. Crandall, and Bulletin 287 of the New York (Geneva) Station by Prof. U. P. Hedrick, treat of bordeaux mixture and bordeaux injury in relation to the apple in a very comprehensive and exhaustive manner, and these publications are recommended to any who wish further information on this subject.

Leaf spot. Spotting of the leaves is closely associated with the russeting of the fruit by spray. However, a study of this trouble extending over several years and representing material collected in many different parts of the State shows that leaf-spot in Maine is by no means confined to that caused by the use of sprays. In 1908 leaf-spot was exceedingly abundant on unsprayed trees all over the State. As is stated elsewhere in this bulletin (p. 359) various fungi were found in these spots on leaves from sprayed and unsprayed trees, but of these *Sphaeropsis malorum* Pk. was the only one which was capable of causing the disease on inoculation from pure cultures.

While in some instances the spots caused by sprays did not appear quite identical with those caused by the fungus, these differences were not constant enough to enable one to distinguish one from the other with any degree of accuracy. Moreover old spots made by sprays were usually attacked by fungi so that it is only by knowing the history of the case and noting the relative amount of spotting of leaves on sprayed and unsprayed trees under like conditions that one is able to judge whether the spotting is caused by sprays or fungi. Fig. 240 illustrates spotting caused by spraying and Fig. 241 spotting caused by *Sphaeropsis malorum.*

The first indication of the formation of a leaf spot is the appearance of minute specks on the leaves where the healthy green has changed to a reddish or purplish color. Soon these change to larger, dead, brown spots, usually quite sharply defined against the adjoining green, though in severe cases of spray injury the whole leaf begins to turn yellow and soon drops off, resulting in many instances in partial defoliation. As a rule the spots are round, or oval and quite regular, but they may be of various shapes and sizes.

It has been claimed that lime-sulphur sprays do not cause leaf-spot. The experiments already referred to (p. 346) which were conducted by Mr. Bonns in 1910 with lime-sulphur and similar substitutes for bordeaux mixture used with lead arsenate as an insecticide, indicate that exceptions to this statement may be expected when these sprays are tried on the more tender varieties like the Ben Davis.

Experiments conducted at Orono by the writers in 1908 and 1909 with self-boiled lime-sulphur in comparison with bordeaux mixture on Milding, Fameuse and McIntosh resulted in no injury with either spray. Moreover published reports of spraying apple trees in Arkansas, Oregon, Missouri, New York and New Hampshire, with self-boiled, home-cooked and certain of the commercial lime-sulphur sprays are agreed as to the absence of spray injury from lime-sulphur. However, in our own experiments and in some of the others mentioned the trees used were not those which are particularly susceptible to bordeaux injury, and while the results are of value as showing the fungicidal value of lime-sulphur, they do not show that it would not produce spray injury on the more tender varieties. Much more experimentation will be necessary to determine this point; hence it is impossible at this time to state with any degree of accuracy what may be expected from the lime-sulphur sprays in the line of spray injury. However, there is every reason to believe that it may be used on the more tender varieties with much less danger of injury than with bordeaux mixture. It is probable that the combined use of the two would yield the more satsifactory results. That is, for the more tender varieties, use bordeaux mixture for the first spraying, in the spring before the leaves unfold, followed with lime-sulphur for the later sprayings.

Baldwin spot. The disease which is generally known in Maine under this name is not of fungus origin. It takes its name from the fact that it was first observed on and occurs most commonly on Baldwin apples, but it is not confined to that variety.

This disease is characterized by sunken spots distributed irregularly over the surface of the apple, as shown in Fig. 242. These spots are somewhat hemispherical in shape. They vary in size from one-eighth to one-fourth inch in diameter and have very much the appearance of bruises. An examination of the tissues

beneath shows that they are brown in color and have become somewhat dry and spongy. In some cases the Baldwin spot appears on apples as they are ripening but in other cases it develops in storage. It may be confined to individual trees in an orchard or to certain branches of a tree.

In late stages the tissues beneath the spots become shrunken so that the pitting is deeper. The brown coloring is not confined to the region just beneath the spot but is found also in the tissues surrounding the vascular bundles in later stages.

This disease should not be confused with the spot of apples caused by the fungus *Cylindrosporium pomi* Brooks, see page 356. The fungous disease can be controlled by spraying but the Baldwin spot cannot be controlled by that means. The writers believe that confusion of these two spots of apples in the past is responsible for reports which have been made of the control of Baldwin spot by spraying. The cause of the trouble is not well understood and until this is known little can be done toward finding methods of prevention.

In many of the earlier descriptions, spots on apples caused by the fungus were confused with spots which are not caused by a fungus and a composite description was made. In New Hampshire Experiment Station Report 20, p. 342, Brooks says: "It would be difficult to decide from the earlier descriptions given in the bulletins of the New Hampshire Station whether the Fruit Spot or the Fruit Pit (the original Baldwin spot) was under special observation. The descriptions are better if taken as applying to the two diseases than if considered as applying to either to the exclusion of the other. The spraying experiments were undoubtedly made upon the Fruit Spot. So far as the writer has been able to learn, a distinction between these two diseases has never been made."

The fact that the two diseases were sometimes confused and considered as one before the time of Brooks' publication together with the name which he has applied to the fungous disease has led a number of people to conclude, without careful study of the distinction which he has made, that all of the spotting of Baldwin apples is due to the fungus *Cylindrosporium pomi.*

The observations of the writers have convinced them that the Baldwin spot is of common occurrence in Maine, and that apples affected by this disease are more seriously injured than are Baldwin apples affected by the fungous disease.

Hail injury. During the past 2 or 3 years different parts of the State have experienced hail storms of sufficient severity as to badly injure the young fruit on the apple trees. There is nothing which can be done to prevent this injury, but frequently it is not noticed at the time and is later attributed to fungi, insects or other causes. The fruits may be badly deformed and scarred resembling somewhat curculio injury but the characteristic crescent shaped scars of the latter are not present. Quite frequently hail injury is followed by fungous decays of the fruit resulting from infections of the wounds.

Stag horn. Very frequently apple trees are seen with the topmost branches dead and remaining as dry sticks like antlers projecting above the foliage. This condition may be due to various unfavorable conditions, but in Maine it is chiefly encountered with old trees which have long remained unsprayed, unpruned, uncultivated and unfertilized. This allows opportunity for wood destroying fungi to gain an entrance. Once started their growth will eventually destroy the whole tree. Severe heading back and clearing out of the dead and fungus infested wood followed by cultivation and fertilization should be resorted to. In some instances it may be necessary to top-graft to renew the head of the tree. The full results of such treatment do not show the first year. Great care should be taken not to leave wounds through which the spores of fungi can gain an entrance to cause future decay.

Lichens on apple trees. Not infrequently complaints are received, particularly from coast towns, with regard to fruit trees being over-run by lichens, sometimes improperly called "mosses" by orchardists. While mosses are not uncommon on old, neglected fruit trees, lichens are much more frequent. The latter are foliacious growths of various colors, the more common being grayish and found indiscriminately upon trunks of trees, rocks, old fence boards, etc. Quite frequently these lichens are found in large numbers upon orchard trees—apples, pears and plums—particularly so in the states farther south. Fig. 244 represents a portion of a branch from a neglected Maine apple tree. A large proportion of the branches were covered with lichens as shown in the illustration.

In temperate climates lichens occurring on tree trunks are not considered to be parasitic. In the tropics there is evidence that

one or more kinds are probably parasitic. However, all are agreed that lichens are decidedly objectionable on fruit trees. They harbor insects and fungi, tend to keep the branches moist and more likely to decay, besides being untidy and unsightly. While they may not secure any nourishment from the trees they certainly must interfere seriously with the functions of the bark on the younger limbs.

Two or 3 pounds of copper sulphate to 50 gallons of water or a 5-5-50 bordeaux sprayed on the trees before the buds swell in the spring will generally destroy the lichens. A wash such as is used for borers consisting of one pound of potash or concentrated lye to 5 gallons of water, put on with a brush, is said to be effective. *None of these materials should be sprayed on the trees when in leaf on account of injuring the foliage.* Thorough spraying with 3-3-50 bordeaux in the spring and early summer, as recommended for apple scab and other fungous diseases, would doubtless do much to hold the lichens in check, if not destroy them altogether. Hence, if the orchard is well cared for and sprayed it will not be infested with lichens.

Parasitic Diseases.

DISEASES OF THE FOLIAGE AND FRUIT.

Scab. Probably no other disease of the apple is of so much economic importance to Maine orcharding as the common apple scab caused by the fungus *Venturia pomi* (Fr.) Wint. The losses from this disease are not so much in the destruction of the fruit as in the lowering of its market value. On account of the attacks of this one disease, which is largely preventable, the financial returns from the orchards of many sections of the country are reduced from 25 to 50 per cent yearly.* Were it properly controlled in Maine a large proportion of the crop of some varieties which now goes as No. 2 and No. 3, might be marketed with the No. 1 grade. Moreover where spraying operations have not been generally practiced the importance of this fungus is in no way realized. For years it has been common and widespread, particularly on certain varieties and the orchardist has learned to regard it as one of the things to be

* Duggar, B. M. Fungous Diseases of Plants. p. 265, 1909.

expected and not as something which can and should be prevented.

The apple scab fungus may attack the flowers, twigs, leaf-stalks, leaves and fruit but it is upon the last two that its appearance is most prominent. While severe attacks on the leaves do much to weaken the trees, often causing considerable defoliation, the direct monetary loss to the orchardist is greatest from the effects of fruit injury for the reasons mentioned above.

Scab appears on the leaves in the form of a superficial, somewhat velvety, olive-colored growth, darker than the leaf green.* This growth is more likely to be observed on the under side of the leaf but both sides may be attacked. It may occur in spots but is frequently more abundant along the line of the mid-rib and large veins. The later stages may be compact, thin-scurfy, or more frequently especially if viewed with a magnifying glass of low power it will be seen to be ramifying and much branched giving a beautiful, delicate, "moss agate" effect. Badly attacked leaves may be more or less curled and crinkled and where defoliation occurs a pronounced yellowing may appear. Fig. 247 shows the characteristic appearance of a well developed leaf attack where the spots have run together along the veins.

Scab on apple leaves was very abundant in Maine during the summer of 1910 and samples showing the disease were received by the Experiment Station repeatedly from all of the apple growing sections of the State. Cool, moist weather either in the spring or summer favors the development and distribution of scab, while hot, dry winds and sunny days tend to keep it in check.

Two forms of spores are produced on apple leaves. If some of the olive-colored growth from the living leaves where the fungus is growing parasitically is scraped off and examined under the microscope a large number of the summer stage spores are found. These, and like spores produced on the fruit spots, are responsible for the summer spread of the disease. In the winter the fungus develops saprophytically in the fallen leaves under the trees and there produces an entirely different type of spore. While the summer spores can live for some time and doubtless it is not impossible for them to remain alive over win-

* Before the spores begin to form the affected areas are of a lighter green than the healthy parts of the leaf.

ter especially on fruit left on the trees or on the ground it is probable that much of the spring infection comes from the winter spores formed on the fallen leaves. It is a matter of common experience that the lower leaves on the tree are the first to show attacks of scab in the spring. Hence raking and burning the leaves would do much to lessen the danger of infection. The formation of winter spores takes place more readily when the leaves fall on sod or are partly covered by grass, other leaves, etc. Orchard cultivation produces conditions unfavorable to the propagation of scab spores and early spring plowing buries many of them where they will decay and do no damage.

Scab on the fruit is too familiar to need much description. It first appears as small, circular, olive-colored spots on the skin of the apple, these later enlarge, many of them becoming one-fourth of an inch or more in diameter, roundish, roughish and dark olive-colored, usually surrounded by a light gray border. Several spots may coalesce and form irregular patches, sometimes covering a large portion of the apple. In severe attacks, especially those resulting from early infections when the fruit is small, the apples often become cracked and badly distorted in shape due to the unequal growth of the healthy and diseased portions. Fig. 245 represents an apple in this condition.

While scab on the fruit is largely a superficial growth, the injury it does directly and indirectly is by no means confined to simple damaging of the appearance of the fruit. As is pointed out elsewhere in this publication (p. 364) epidemics of pink rot and some of the blue mold decay come from secondary infections of these fungi through scab spots. Scabby apples in addition to being more likely to decay wither more rapidly in storage than do perfect apples.

In a former publication of this Station attention was called to what then appeared to be a rather novel and uncommon form of the development of scab on apple fruit—its appearance and growth on apples in storage cellars.* Since the publication of this article certain more or less general statements have been found in the early Station literature indicating that somewhat the same thing had been noted and recorded at least 20 years

* Morse, W. J. Me. Exp. Sta. Bul. 164, p. 4, 1909.

before.* From information collected since publishing the account above referred to, it would seem that the appearance and spread of apple scab in storage is by no means uncommon in eastern States but in the past it has been largely overlooked.

Apple scab in storage may develop on fruit which, when placed in the cellar, appeared entirely free from the disease. It differs in appearance from the spots formed out-of-doors so much that at first one is doubtful as to the identity of the two diseases. Cultures made from the storage developed spots settled this point beyond doubt. Instead of soon breaking out and producing olive-colored summer spores the fungus usually remains beneath the unruptured cuticle, and the diseased portions appear as slightly sunken, small, black, somewhat shiny spots. As observed in Maine these storage developed spots have always been much smaller than those produced out-of-doors. Many of them are only of pin-head size. Brooks, however, has shown that they may attain a much larger size.** Fig. 246 shows the characteristic development of apple scab in storage. Doubtless much of the infection takes place immediately before or at the time of picking, but in one instance, at least, observed during the past winter, the evidence plainly indicated spread in storage. In a box of very clean No. 1 McIntosh, packed for perfect apples, one bearing a medium sized scab spot covered with spores was placed by accident. This box was placed in a relatively cool but quite moist cellar and when opened by one of us in mid-winter several apples lying immediately below the summer-scabbed apple were covered with the small black spots above described. The remainder of the fruit in the box was without blemish of any kind

Directions for the control of apple scab by spraying will be found on p. 390. Fruit from trees that are well sprayed will be less likely to develop the disease in storage. Scabby apples should be carefully sorted from the sound before storing. The temperature of storage should be as low as consistent with safety and not subject to abrupt changes. Very moist storage conditions should be avoided.

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* Garman, H. Ky. Exp. Sta. Rep. 2, p. 48, 1889.
McCarthy, Gerald. N. C. Exp. Sta. Bul. 92, p. 88, 1893.
Henderson, L. F. Idaho Exp. Sta. Bul. 20, p. 83, 1899.

** Brooks, Chas. N. H. Exp. Sta. Bul. 144, p. 113, 1909.

Cylindrosporium fruit spot. This spot of apples which was first described by Brooks* is caused by a fungus, *Cylindrosporium pomi* Brooks. It should not be confused with the disease of apples which has been known for several years as Baldwin spot and which has been studied by a number of investigators. The Baldwin spot is not caused by the growth of a living organism, as has been proved a number of times by men working in widely separated places.

In Brooks' paper he has distinguished very clearly between the two diseases, but the writers regard it as unfortunate that he has substituted the name "Fruit Pit" for a disease which has been generally known in other parts of New England under the name "Baldwin spot," because certain writers and others have erroneously used the term "Baldwin spot" so as to include an entirely distinct disease. It is freely admitted, however, that if no confusion would result and the disease were being described for the first time, "Fruit Pit" is a more accurate descriptive term. In a recent text-book on plant diseases, the *Cylindrosporium* disease has been indexed as "Baldwin Fruit Spot" and this leads to more or less confusion. The writers have heard the opinion expressed a number of times that the cause of Baldwin spot was explained by Brooks' study of this fungus. They wish simply to assist in making clear the fact that Brooks recognized and described two distinct diseases and that the disease caused by *Cylindrosporium pomi* is not the same as the well known Baldwin spot, the characters and occurrence of which were so well pointed out by Jones.** Unfortunately in Jones' account of Baldwin spot he includes the results of Lamson's apparent control of the disease by spraying with bordeaux mixture. Brooks shows, however, that there is every reason to believe that Lamson's results were really from the control of the *Cylindrosporium* fruit spot which he confused with the true Baldwin spot.

The *Cylindrosporium* fruit spot occurs on a number of varieties of apples, and the writers are convinced by their observations that it does much more damage to some other varieties like the Bellflower in Maine than it does to the Baldwin.

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* Brooks, Charles. The Fruit Spot of Apples. N. H. Exp. Sta. Report 20: 332-365. 1908.

** Jones, L. R. Vt. Exp. Sta. Rep. 12, p. 161. 1899.

According to Brooks, the *Cylindrosporium* disease appears first about the middle of August. (The true Baldwin spot does not appear till nearly harvest time or in storage). When it first appears one notices spots of deeper red on the darker colored portions and darker green on the lighter portions of the surfaces of affected apples. At this stage they are but slightly sunken, if at all, and there is no suggestion of a bruise. From Brooks' studies it appears that the fungous spots on red surfaces become more sunken later in the season, the color gradually changes from brown to black, and in cellar storage the red spots become badly browned and sunken. The green spots may take a similar course but in many cases there is no marked change in their surface appearance. However, according to the experience of the writers, the spots caused by the fungus are not as a rule so large and do not produce such deep pits in the surface as are characteristic of later stages of the non-parasitic trouble. Also on the lighter skinned apples there is not so much danger of confusing the two troubles when one once has the characters of each clearly in mind.

On yellow-skinned apples like the Bellflower the spots are very conspicuous at harvest time. They are of a bright carmine, the older and larger having a darker, brownish center, with seldom any pitting even after some time in storage. The disease is of almost universal occurrence in Maine on this variety— so much so that some apple growers have come to regard the *Cylindrosporium* spots as a natural marking of the variety and frequently exhibit such apples for prizes at fairs and pomological meetings.*

The superficial appearance of apples of the Bellflower variety which are affected with the *Cylindrosporium* disease is quite distinct from that produced by the true Baldwin spot on other varieties as will be seen on comparison of Figs. 242 and 243.

Brooks has made a careful study of the control of the *Cylindrosporium* fruit spot in New Hampshire. He found that infection of the apples takes place in July and that the spots make their appearance in August. He found that either bordeaux

* Following the methods by which the fungus was originally isolated, i. e., by transferring pieces of the browned tissue to tubes of sterile, distilled water, it has been obtained from these spots a sufficient number of times to show its constant association with them.

mixture or lime-sulphur gave good results in the control of the spot if applied at the same time or a little later than for the control of apple scab.

This disease is of common occurrence in Maine and it does considerable damage by injuring the appearance of fruit. Fruit growers should become familiar with the disease and make efforts to prevent the loss which it causes by reducing the price which they receive for their apples.

Sooty blotch and Fly speck of the fruit. These diseases take their names from the appearance which the growth of the fungus gives to the fruit. Both are now regarded by certain writers* as caused by the same fungus, *Leptothyrium pomi* (Mont. & Fr.) Sacc. The fungus does not penetrate into the apple. In the case of sooty blotch, the mycelium spreads over the surface covering areas which vary in size and sometimes practically the whole apple is covered in bad attacks. Fig. 249 is a photograph of an apple affected with sooty blotch. Fly speck is characterized by the development of black shining bodies composed of fungous threads closely woven together, which occur in patches on the surface of the apple.

The chief loss caused by these diseases is in injuring the appearance of fruit and thereby lowering its market value. Neither sooty blotch nor fly speck is of so common occurrence in Maine as they are farther south. Where thorough spraying is done, these diseases are effectually controlled.

Sphaeropsis leaf spot. Leaf spot is a common and widely distributed disease of the apple in Maine. With some varieties and under certain weather conditions a spotting of the leaves is caused by spray injury, see p. 348. It is a matter of common observation, however, that orchards or trees which have never been sprayed are often affected with a spotting of the leaves which in some cases is quite serious.

Affected leaves show little spots of dead tissue, usually somewhat circular in outline. The dead portion is not quite so thick as the surrounding green tissue and takes on a brown color. On the dead spots little black bodies are frequently found which are the fruiting portions of the fungi associated with the spots. The dead spots often show concentric rings.

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* Duggar, B. M. Fungous Diseases of Plants. p. 367. 1909.

Leaf spot of the apple has been discussed by a large number of writers and the cause attributed to a number of different fungi. In many cases the fact that a certain fungus was very frequently found on the spots was taken as sufficient evidence that it was the cause of the disease. Of recent years it has been questioned whether the presence of a fungus on a leaf spot, no matter how constantly it occurred there, should be taken as evidence that the fungus caused the disease. It has been held that it is necessary to isolate the fungus in pure culture and then produce the disease by inoculation under control conditions before the matter could be definitely settled. In the summers of 1906 and 1907 Scott and Rorer* made a study of the disease in the Ozarks in which they isolated fungi from leaf spots and carried on inoculation experiments. Of the various fungi isolated *Sphaeropsis malorum* Pk., the same fungus which causes a destructive fruit rot (p. 362) and limb canker (p. 372)in Maine was the only one capable of causing the disease when its spores were sprayed on the leaves.

On account of the importance of the fungous leaf spot in Maine it was thought desirable to make a thorough study of the pathogenicity and interrelation of the various fungi found associated with leaf spot, fruit decays, and limb cankers in this State. The results of a part of this work have already been published** and other parts will be published later. It is sufficient for our present purpose to state that out of a large number of fungi isolated from leaf spot in Maine *Sphaeropsis malorum* was the only one which would produce the disease on inoculation.

The results obtained here, taken together with the conclusions of Scott and Rorer and the work of Lewis† in New Hampshire would seem to indicate that *Sphaeropsis* is the only one of the fungi occurring so abundantly on the dead spots in apple leaves which is capable of causing the disease in this section of the country.

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* Scott, W. M., and Rorer, J. B., Bureau Pl. Ind., U. S. D. A., Bul. 121, Part V, pp. 47-54. 1908.

** Lewis. C. E. Apple Diseases Caused by *Coryneum foliicolum* and *Phoma mali*. Me. Exp. Sta. Bul. 170. 1909. A New Species of *Endomyces* from Decaying Apple. Me. Exp. Sta. Bul. 178, 1910.

† Lewis, Isaac M., N. H. Exp. Sta. Rep. 20, pp. 365-369, 1908.

This fungous leaf spot causes a considerable amount of loss in Maine orchards and this loss is not always realized by the apple growers. The dead spots in the leaves interfere with their function, and, in addition to this, large numbers of the diseased leaves fall prematurely, thus seriously interfering with the nutrition of the trees.

As has already been mentioned the fungus causes the canker of the wood and the black rot of the fruit, therefore preventative measures must be directed toward all 3 forms of the disease. Since inoculation experiments indicate that in Maine infection must take place before the middle of July spraying as recommended for apple scab would do much to control the disease. This should be supplemented with the removal and destruction of limb cankers and decayed fruit.

From their observations the writers are convinced that leaves of trees which are well fertilized, cultivated and generally well cared for are not so susceptible to the disease as the leaves of neglected trees. It must be borne in mind, however, that a similar spotting of the leaves of susceptible varieties may occur as the result of spray injury.

Rust. This disease of apple leaves and fruit which does great damage in some apple growing districts does not seem, according to the observations of the writers, to be of very common occurrence in Maine. The fungi* which cause this trouble pass a part of their life upon the apple and related plants and a part upon the red cedar where they cause the abnormal development of small brown knots on the twigs which are known as "cedar apples." In the spring these knots produce thread-like tubes which when wet with rain swell up, become gelatinous, are orange-yellow in color, and throw off large quantities of spores. These spores are capable of infecting apple leaves and are produced when the latter are young and most susceptible to infection.

On the apple leaf there is first a thickening of the tissues in small spots at the points of infection. Later in the season these thickened places become ruptured on the under side and short,

* Apple rust may be produced by *Gymnosporangium macrocarpus* Lk., or *G. globosum* Farl. It is not known which species is responsible for the rust in Maine but probably it is the latter. The red cedar, *Juniperus virginiana* L. is the alternate host for both.

thread-like growths project beyond the broken epidermis. Orange-colored spores are formed in these places. It is on the leaves and fruit of the apple that the injuries caused by this rust become of economic importance. Spraying has not been very successful in controlling this disease. Where the rust appears, the removal of red cedars from the neighborhood of apple orchards is recommended.

Powdery mildew. The common name for this trouble comes from the appearance of the affected leaves which is shown in Fig. 248. The fungus, *Podosphaera oxyacanthae* (DeC.) DeBary, grows upon both surfaces of the leaf but does not penetrate the tissues, except to throw in short feeding branches. During the summer many spores are formed and it is the masses of spores which give the white powdery appearance. The parasite spreads rapidly by means of these summer spores. Later in the season another stage of the fungus develops on the diseased leaves and this is indicated by the presence of small but plainly visible, spherical, black bodies which are scattered here and there among the white mycelium. Spores are produced in these bodies which carry the fungus over winter.

On the apple, the chief damage done by this fungus is in its attacks upon nursery stock where it causes considerable loss. Spraying with diluted lime-sulphur should go far toward controlling this disease.

FRUIT DECAYS.

During the past 3 years this laboratory has devoted considerable attention to a study of the fungi which cause decay of apples in Maine. Fungi have been isolated from decaying apples from various places and these have been tested by means of inoculations in order to determine the extent to which each was capable of causing decay. It has been found that Maine has a considerable number of the apple decay fungi which have been described from other places but the relative amount of rot caused by some of these fungi under local conditions differs materially from the amount attributed to the same fungi in other parts of the United States. For example the "bitter rot" fungus while it occurs here does very little damage in comparison with the amount of loss resulting from its attacks in other sections. The apple decays which have been found in Maine will be described

in the following pages together with the means of control so far as these measures are understood.

Black rot. This rot is caused by *Sphaeropsis malorum* Pk. which also causes a decay of pear and quince. The fungus attacks apples both on the tree and in storage and is responsible for much of the rot on the trees in this State. It is capable of causing decay of green fruit but its progress is much more rapid in apples which are ripe or nearly ripe. Early apples are especially susceptible. As a cause of storage decay, *Sphaeropsis* probably ranks second to *Penicillium* which is described below. On account of the relation to leaf-spot, and limb cankers as well, the black rot fungus in distribution and economic importance probably ranks second in the State to that which causes apple scab.

Black rot of the apple takes its name from the appearance of the fruit in the late stages of the decay. In early stages, the decayed region is brown in color but the mycelium of the fungus takes on a dark color with age and thus colors the apple. The fungus usually enters the apple at either the blossom or stem end, and, if the temperature is favorable for growth, spreads rapidly and causes the complete decay. The decaying region is marked by concentric rings. When the mycelium has grown in the apple for a sufficient length of time the threads begin to form little aggregations just beneath the epidemis which develop into the small black bodies which later break through the epidermis. The spores of the fungus are formed inside these bodies and escape through an opening at the apex. The appearance of an apple in this stage of the decay is shown in Fig. 250. There is only one other fungus (*Phoma mali,* see p 365) which in Maine causes a similar appearance of decayed apples and the amount of loss caused by that fungus is small as compared with the loss caused by *Sphaeropsis.*

Since the fungus which causes the black rot of apples also causes a disease of the wood and leaves, any means of control of the rot must take into consideration these sources of infection of the fruit. Old, diseased trees are almost certain to produce *Sphaeropsis* spores in large numbers on dead and dying limbs and these spores are ready to infect the apples as they mature and to cause their decay. One good means of control then is to remove the source of infection by cutting out and burning all

dead and diseased wood. All decayed fruit should also be destroyed. If this is followed by the spraying which is recommended for apple scab it will go far toward the control of this disease.

Penicillium or blue mold decay. This is the rot of apples which is caused by the common blue mold which is familiar to every one on preserved fruits, jellies, etc. Blue mold grows as a saprophyte on a large number of dead organic substances and produces large numbers of spores so that the spores are practically everywhere present and may start a new growth of the mold whenever they fall upon a substance which furnishes a suitable food supply provided that the temperature is favorable for growth. It is a widespread cause of decay in Maine, especially where the fruit has not been carefully handled.

This decay of apples is probably caused by more than one species of this genus. In some cases other fungi aid in the decay but since *Penicillium* breaks out and shows more prominently on the surface of the apple, it is often held responsible for more of the decay than it causes. There can be no doubt, however, that one or more species of *Penicillium* cause a large amount of the soft rot of stored apples. This is primarily a rot of ripe apples and does not cause decay of green fruit. The threads of the fungus cannot penetrate the uninjured epidermis of the apple but must gain entrance through injured places such as bruises, cuts, cracks, worm holes, spray injured places or scab spots. It spreads rapidly in ripe apples and complete decay takes place in one to two weeks. The tissues become soft and are light brown in color. Little tufts of mycelium which bear the spores break out on the surface of the decayed region as shown in Fig. 251. These tufts soon become light blue or blue-green, later gray-green to brownish in color. Apples rotted by *Penicillium* take on a characteristic moldy odor and taste.

Since the fungus enters the apple through wounds, any means of control of the rot must look to the prevention of injuries to the epidermis. Care must be taken to produce good, sound apples and then these should be picked and handled in such a way as to avoid cuts and bruises. The apples should be stored where the temperatures are as low as can be maintained with safety from freezing.

Bitter rot. This disease which does so much damage in some

apple growing regions is caused by *Glomorella rufomaculans* (Berk.) Sp. & von Sch., and is found occasionally in Maine, but its occurrence is so rare that it is not necessary to recommend special means for its control. Moreover it does not seem that bitter rot will do great damage under Maine climatic conditions if the recommendations with regard to the removal of cankers and spraying are followed as are given for the black rot fungus. Where bitter rot is prevalent spraying later in the season is necessary. Fig. 252 shows the appearance of this rot. The fungus found here differs in certain characteristics from the form described from farther south and there is some evidence from our inoculations that it is not so actively parasitic.

Brown rot. The brown rot of the apple is caused by *Sclerotinia fructigena* (Pers.) Schroet., the same fungus which causes the destructive brown rot of peaches and plums. This decay of apples occurs to some extent in Maine and in some cases may do considerable damage. The fungus spreads through the apple rapidly and in the early stages the surface of the decayed region is smooth and brown. Later little tufts of fungus threads break out on the surface of the apple and these produce the spores as shown in Fig. 253. Often when this rot takes place in storage, away from the light, the tufts of spores do not break out on the surface and the skin assumes a shiny black color. The apples become shrunken and wrinkled as they dry and in some cases these mummied apples hang on the trees over winter. It is these mummied apples which carry the fungus over from one year to another and for that reason all decayed fruit both on the trees and on the ground should be destroyed. The spraying for apple scab will also help to control this fungus.

Pink rot. In some seasons, especially when it is warm and wet at the time of harvesting, scabby apples are attacked by a fungus, *Cephalothecium roseum* Cda., Fig. 254. This is called pink rot on account of the appearance of the spots where the fungus grows out to produce its spores. The fungus, usually a saprophyte, occurs on a large number of dead parts of plants. Therefore, the material for the infection of apples is present whenever the conditions are favorable for the growth of this fungus. The fungus is unable to penetrate the uninjured epidermis of the apple and scab spots afford the chief means of entrance. To avoid loss from pink rot it is necessary to produce apples which are free from scab.

Alternaria decay. A decay of apples caused by a species of *Alternaria* was first described from Colorado by Longyear.* This fungus entered the apple at the blossom end and produced a cob-webby growth of mycelium around the seeds. An *Alternaria* has been found a number of times associated with apple decays in Maine. This fungus usually occurs on injured places such as the blossom end injured by insects or broken places in the skin. Associated with other fungi this *Alternaria* forms a rather thick, dry covering of mycelium over the injured place. The fungus does not usually penetrate very deeply in such cases but when ripe apples are inoculated from pure cultures, it is found to be capable of causing a complete decay. This fungus alone has been reisolated a number of times from decaying apples which had been inoculated, thus proving that it caused the decay. The apple decay *Alternaria* differs sufficiently from a species of the same genus which has been found repeatedly on dead spots in apple leaves and on dead parts of other plants so that the two fungi can be distinguished readily in culture. The *Alternaria* from apple leaves has not been found to cause decay of the fruit upon inoculation.

Botrytis decay. A species of *Botrytis* causes a part of the decay of apples in Maine. It has been found causing a rot of early apples on the tree and inoculations have shown that it not only attacks ripe fruit but that it is capable of causing a rot of green apples. The fungus spread, rather rapidly in the tissues of winter apples which were inoculated early in August so that in 2 weeks one-half of each apple was decayed. It causes a rapid and complete decay of ripe apples.

Phoma decay. This rot is caused by *Phoma mali* Schulz & Sacc., which is able to attack both wood and fruit. A more extended account of this fungus is given in Bulletin 170 of this Station. It causes only a slight decay of green apples but when ripe apples are inoculated the rot spreads almost as rapidly as in the case of some of the well known apple destroying fungi. When the fruit is thoroughly invaded the pycnidia break out on the surface giving somewhat the same appearance as in the case of black rot but there is usually considerable mycelium on the surface of the apple and this is white in color. The appearance of an apple 34 days after inoculation with *Phoma mali* from a

* Longyear, B. O. Col. Exp. Sta. Bul. 105, 1905.

pure culture is illustrated in Fig. 255. The fungus was reisolated in pure culture from this apple.

Hypochnus decay. Eustace* has described a decay of apples in New York caused by a species of *Hypochnus.* A fungus which agrees in certain characteristics with the one described by Eustace has been found here associated with a surface spotting or pitting somewhat like the Baldwin spot and *Cylindrosporium* troubles of apples. The fungus which we have had in culture for 3 years has never fruited, although it has been grown on a variety of culture media and so it is impossible to state positively that it is the same fungus which Eustace studied but it has the same kind of clamp connections of the cells of the mycelium and the fungus agrees in appearance with his description. Inoculations with this fungus caused only a small sunken spot of decayed tissue at the point of inoculation.

Fusarium decay. The examination of decaying apples from a large number of sources has frequently shown the presence of *Fusarium* spores. In some cases *Fusarium* has been found fruiting on the surface of decayed fruit, the rather thick masses of spores giving a pink color, in other cases the mycelium has been found in the cavity around the seeds sometimes destroying the seeds. In the seed cavity it is either white or reddish in color. The spores are produced in considerable numbers on this mycelium. *Fusarium* is sometimes found associated with other fungi forming a thick felt-like growth over injured places on the surface of apples. From such a growth on one apple one of us (L.) has isolated 8 different fungi, 4 of which, including one species of *Fusarium,* caused complete decay of ripe apples upon inoculation from pure cultures. In advanced stages of *Fusarium* decay, white mycelium breaks out on the surface of the apple as shown in Fig. 256. A study is being made of the apple decays caused by species of *Fusarium* and a detailed account will be published soon in a bulletin of this Station. A *Fusarium* decay has been described from Europe by Osterwalder,† but so far as the writers are aware no such decay has been reported in America. In this investigation 3 forms of *Fusarium* have been

* Eustace, H. J., N. Y. State Sta. Bul. 235, pp. 123-129. 1903.

† Osterwalder, A. Ueber eine bisher unbekannte Art der Kernobstfäule, verursacht durch *Fusarium putrefaciens* Nov. spec. Centralbl. Bakt. Zweite Abt. 13. 207-213; 330-338. 1904.

isolated from decaying apples, and have been found to cause decay of both green and ripe apples. These have been grown in pure culture from one to two years and show such differences in cultural characteristics as to make it seem probable that they are different species. One of these bears considerable resemblance to *F. putrefaciens* Osterwalder, but does not seem to be identical. One of the others has been found to cause not only a decay of apples but to cause decay of parts of a number of other plants. Its occurrence on one of which at least practically insures the presence of spores of this fungus at the time when the infection of the apple would take place.

No special recommendations can be made for the control of these apple rots at this time. In a general way it may be said that the same methods which apply in the case of the well known apple decays will probably go far toward the prevention of loss from these fungi.

Verticillium decay. In 1908, a fungus was isolated from apples and tested by means of inoculations which, while it does not seem to be of very common occurrence, causes a distinct decay of both green and ripe apples on inoculation. This fungus spreads through the tissues of ripe apples at as rapid a rate as *Penicillium* but it produces a very different effect. The diseased portion is not soft but is rather hard and the affected apple keeps its normal shape for some time. The decayed tissue has an odor and taste which is characteristic and rather pleasant, not unlike that of dried cocoanut. Cultures of the fungus on prune agar give the same odor.

The causal fungus grows readily and spreads rapidly in plates of prune agar. It produces large quantities of spores. The masses of spores are white when young but become green with age. On the basis of the spores and of the manner in which they are borne in culture this fungus has been classified as a species of *Verticillium*. It is possible that this fungus, which is capable of causing a distinct decay, may be responsible for a part of the rot which is attributed to other fungi for when apples were inoculated with it, the fungus did not break out on the surface and produce spores.

Endomyces decay. In Bulletin 178 of this Station a new species of *Endomyces* is described which was found to cause a decay of ripe apples but which did not attack green fruit. This

fungus is of interest not so much on account of its economic importance, but because it represents a genus new to America.

Rhizopus decay. A soft rot of over-ripe apples is sometimes caused by black mold. This rot may be recognized by the fact that the mycelium which grows out over the surface of the affected apple is composed of thicker threads than are found in other apple decay fungi. If apples attacked by the black molds are kept in a warm, moist place the mycelium forms a thick growth on the surface. The spores are borne in little capsules on the ends of long stalks. When the spores are mature the whole mass becomes black in color.

The black molds are regarded as saprophytes as they are able to attack only ripe apples. They may cause considerable loss, however. To prevent this loss it is necessary to use the same precautions that are taken in the case of blue mold.

Other apple rots. In the course of the study of apple diseases, fruit has been inoculated with a number of other fungi isolated from wood, leaves, or fruit of the apple in order to determine whether these fungi are capable of causing decay. *Coryneum foliicolum* Fckl., and a species of *Cytospora* from diseased wood, produced a small amount of decay; *Coniothyrium pirina* (Sacc.) Sheldon, *Phyllosticta limitata* Pk., *Cladosporium herbarum* (Pers.) Link, and 3 undetermined species of *Aspergillus,* showed a little growth at the points of inoculation but did not spread to cause decay. One fungus which has been determined as *Dematium pullulans* DeBary has been found constantly associated with diseased apple tissues not only of the fruit but also of the leaves and wood. On account of the constant association of this fungus with apple rots, it was tested by means of inoculations but it did not cause decay. It may be possible, however, that when associated with other fungi the decay is hastened by its presence.

DISEASES OF THE WOOD.

Canker and Twig-blight. The term canker has become such a general one as not to admit of easy definition. It is commonly used to describe the condition of branches of trees in which an area of bark has been killed and has broken away so that a portion of the wood is laid bare or is covered only by cracked and roughened bark which does not protect the wood. In the

writers' opinion the term "canker" as applied to diseased areas on trees should be restricted to those characteristic lesions on the trunk and limbs which are the result of alternate attempts to heal, with the formation of new wood, followed by farther killing of the living tissue. In early stages of development, cankers show a region of sunken discolored bark and it is only in later stages that the bark breaks away. Cankers have been described as caused by frost, sun-scald, fungi, and bacteria. A considerable number of different fungi have been reported as causing canker of apple trees in different parts of the United States. These vary greatly in the amount of damage which they do in different regions. In some cases, a fungus which causes a great amount of injury to the trees of one region occurs rarely or not at all in another region.

The injury of apple trees through winter-killing is discussed on pages 341-344. Much of the disease of apple trees which Maine orchardists have been calling canker for the past 3 years had its origin in the severe winter of 1906-7. Some of the injuries resulting from that winter and the seasons following might possibly be properly classified under the term "frost canker." On the other hand, when whole trees were so badly injured that they died either that year or the year following, the injury was too wide-spread and acted too quickly to be regarded as canker. There are a number of forms of winter injury and the frost canker is only one of them. The frost canker is a local injury which tends to heal over under favorable conditions for growth unless the new growth is killed by another period of low temperature before it has become hardened. In this way the frost canker may spread, or in other cases the injured bark may serve as a place for the entrance of a parasite which may then spread in the bark and outer layers of wood and kill a rather large area in a single year.

So far as they have been investigated it has been found that the organisms which cause canker of fruit trees in Maine are, in a large measure, wound paratites. They are unable, as a rule, to penetrate the uninjured bark but must enter through wounds. In this sense, the places injured by freezing serve the same end as wounds of any other kind. However, it may be pointed out that cankers caused by fungi do not spread so rapidly as to kill trees in the short time which has been observed in the case of winter-

killed trees in this State. In the case of young trees the fungus may in some cases girdle the tree in a few weeks and thereby cause its death. The same holds true of small branches of old trees, but in the case of large branches the fungus usually spreads but a few inches each year forming true cankers, and the rough, blackened areas that are frequently seen on large branches often represent a development of several years. The living tissues attempt to heal over the wound by the formation of callus and in some cases with considerable success. Often the parasite ceases to spread in the bark when the dry season of summer comes on and a crack forms between the healthy and diseased bark. The following year the diseased area may continue to spread or the callus may check it considerably. Often other fungi, some of them saprophytes, grow upon the dead bark. Thus it may be seen that while fungi which enter through winter injuries may spread and ultimately do great damage to the tree, there is no reason to believe that the death of large trees which was observed in Maine orchards immediately following the winter of 1906-7 was due to a parasitic organism because the trees died in many cases in too short a time for their death to have been caused by such organisms. On the other hand, there were many places injured by that winter, which became infected by fungi. Where these have been neglected the diseased areas have spread from year to year and have done much damage, often developing into true cankers.

There are many other wounds than those caused by freezing through which parasitic fungi may enter. By this it is not meant that every wound that is made in the bark will necessarily become infected and develop into a diseased area. Frequently small wounds in the bark of young branches heal over quickly, without infection and no serious damage is done. In many cases, however, the spores of parasitic fungi are carried to wounds. This is especially liable to be the case when diseased branches are allowed to remain on the trees, or old neglected trees in the neighborhood produce abundant crops of fungus spores from year to year. Some of the ways in which wounds are made are: Barking of trunk and branches by machinery in cultivating and caring for the orchard; injuries by ladders and by men in picking fruit; branches are sometimes injured by props used to support a heavy load of fruit especially when they

are carelessly placed in position; in some cases hail-stones split the bark of small branches. Care should be taken to avoid any injury which is within the control of the orchardist. Wounds are sometimes kept from healing over by the woolly aphis which forms little cottony patches in wounds and by delaying the healing over process makes a favorable place for the entrance of a parasitic fungus.

Maine has only a few of the fungi which have been reported as causing canker in other parts of the country. Each section of the country seems to have one fungus which is responsible for a large part of the canker in that region. In this State, the fungus which causes the greatest damage is the black rot fungus, *Spaeropsis malorum* Pk.; the bitter rot fungus occurs only very rarely in this region; *Myxosporium corticolum* Edgerton, is very common and apparently does some damage although it does not seem to be a very active parasite; *Coryneum foliicolum* Fckl., and *Phoma mali* Schulz & Sacc., have been described in Bulletin 170 of this Station as causes of disease in this State; *Cytospora* sp. may cause some damage but it is not extensive. The European apple canker caused by *Nectria ditissima* Tul. and the blister canker, *Nummularia discreta* Tul., may be present in the State but they have not been observed.

Closely associated with canker caused by fungi is the killing back of small branches and twigs caused by the same organisms. In searching orchards in the State for cankers we have found this dying back of the branches and water-sprouts much the more common of the two. The fruiting bodies of the same fungi have been found on both, and cankers on larger limbs have been found repeatedly which apparently started from the disease following back on a smaller branch or twig. Inoculations with canker producing fungi early in the spring show that they are capable of killing the young twigs very rapidly and run back a considerable distance in a single season. A twig blight may be caused by the pear blight bacillus, but pear blight is rather uncommon in Maine. Moreover the entire absence of the characteristic "fire blight" has been noted repeatedly on pear trees growing within and alongside of apple orchards affected with the fungous twig blight.

In many ways the dying back of small branches is like the development of canker. The fungus may spread back only a

short distance each year for a number of years or, as indicated above, the spread is rapid and the branch is killed back a considerable distance in a single year. It is probable that in many instances the young wood is injured by freezing and the fungi gain entrance in this way.* We have observed the same thing where young nursery stock has become infected through wounds made in cutting back when set. Twigs and limbs affected in this way should be cut off well below the diseased portion and the wounds protected from farther infection.

Sphaeropsis canker. The canker caused by the black rot fungus, *Sphaeropsis malorum* Pk., is widely distributed in Maine. This disease is known as "The New York Apple-tree Canker," because it was first described from New York.** This fungus causes the black rot of the fruit and a leaf spot as well as the disease of the wood.

The appearance of different early stages of cankers caused by this fungus is shown in Figs. 257, 258 and 259. The dark colored, cracked bark of the older, central parts, some of the small, black pycnidia or spore bearing bodies, and the crack between the healthy and diseased bark are shown in Fig. 257. This also shows, somewhat indistinctly, where cracks have formed between the healthy and diseased bark at the end of each growing season for at least 3 years. In this and in Figs. 258 and 259 infection probably took place on a smaller twig or branch and followed back to the larger branch as suggested by the small, dead stubs. It is not always possible to see the extent of each season's growth on account of other fungi and lichens growing over the dead bark.

The fungus attacks either young or old branches and the amount of damage depends on the amount of bark and adjoining surface portions of the wood which is destroyed. In some cases a branch may be girdled in a short time and death of that branch results, but in other cases the canker spreads for years on one side of the branch before it is completely girdled. The other side of the branch in such a case may become somewhat enlarged.

To control this canker, the orchardist should remove all dead

* The manner in which young twigs and fruit-spurs become infected by fungi is a matter which needs farther investigation.

** Paddock, Wendell, N. Y. Exp. Sta. Bul. 163, 1899.

branches, and all old neglected trees such as one frequently sees along the roads and burn them. Branches which show bad cankers should be cut off back of the canker and burned. In the case of young cankers, the branch can frequently be saved by cutting away the diseased tissue down to healthy wood, disinfecting with a solution of copper sulphate, one ounce to one gallon of water, or corrosive sublimate, one part to 1000 of water, and then painting over with pure white lead in boiled linseed oil or coating with a good quality of grafting wax. The trees should be gone over carefully a number of times each year and developing cankers and wounds should receive attention. Spraying for apple scab will help to control the cankers by reducing the amount of material for infection and by covering wounds with the fungicide. All decayed fruit should be destroyed, since the black rot of the fruit and this canker are caused by the same fungus. The treatment outlined should go far toward controlling cankers caused by other fungi in this State.

Bitter rot canker. This canker caused by the fungus which causes bitter rot of the fruit is of rare occurrence in Maine. On the dead bark the fungus produces little black pustules from which, when they are mature, pinkish masses of spores exude. The spores from cankers cause much of the early infection of fruit on the tree each year. The appearance of the diseased bark of a young tree caused by inoculation with the bitter rot fungus is shown by Fig. 260.

Myxosporium canker. The fungus causing this disease has been much confused in the past with *Sphaeropsis malorum.* Edgerton's* study of the fungus has shown that the two are entirely distinct. This fungus is of very frequent occurrence in Maine, but its economic importance in this State is somewhat in doubt. So far as observed the damage which it does is confined to killing outer portions of the bark on old limbs and the killing back of the bark on younger limbs and twigs rather than to the production of true cankers. On such branches the fruiting pustules are found on the part which was first killed. The dead bark is separated from the healthy bark by a sharp line and is sunken as is shown in Fig. 261. The appearance of these

* Edgerton, C. W. Two little known Myxosporiums. Annales Mycologici VI: 47-52. 1908.

branches is very characteristic and they can be recognized by one who has become somewhat familiar with the various cankers and twig blights, without microscopic examination of the fungus. There is some reason to believe that the fungus is not a very active parasite and it may be possible that such diseased branches have been injuriously affected by some other agency before the attack of this fungus.*

Coryneum and Phoma cankers. In the examination of apple cankers the spores of *Coryneum foliicolum* and *Phoma mali* have been found of quite frequent occurrence. Inoculation experiments in 1909 proved that both of these fungi were capable of causing disease of healthy bark of apple branches. For a detailed account of the study of these fungi the reader is referred to Bulletin 170 of this Station. The appearance of different stages of *Coryneum* cankers is shown in Figs. 262 and 263.

Cytospora canker. A species of *Cytospora* has frequently been found on small branches which have been killed back but no true cankers have been seen. Those lesions observed have much the same appearance as has been described for branches on which *Myxosporium* is found. After a little experience one can distinguish the two fungi on the bark without the aid of the microscope.

In Bulletin 191 of the New York Station it is suggested that a species of *Cytospora* found on diseased apple branches in that State is probably parasitic. The *Cytospora* which occurs on apple branches in Maine has been isolated, grown in pure culture where it fruits abundantly, and inoculations have been made in small branches in the orchard. The fungus made only a slight development in the injured tissue at the points of inoculation, while inoculations made the same day on the same branches with *Sphacropsis* developed well marked cankers. The indications are that the species of *Cytospora* which is found in Maine is very slightly if at all parasitic.

Pear blight canker. The canker of apple trees caused by the pear blight organism, *Bacillus amylovorus* (Burril) DeToni.,

* The fungus has been isolated from such diseased branches and has been grown in this laboratory upon sterilized apple wood and bean pods for several months. Spores were produced in the cultures about one month after the fungus was transferred from plates to bean pod tubes. Some inoculations have been made and the results of these will be given in a later publication.

which has been reported as causing a great amount of damage in apple orchards in other states, has not been found in Maine, though careful search has been made for it. Almost none of the characteristic twig blight or "fire blight" on the pear which is a good indication of the presence of the organism has been seen. If this disease occurs on the apple in this State, it is of very rare occurrence.

Crown Gall. Apple trees, particularly nursery stock, sometimes have galls or knots which are usually located near the surface of the soil in the region of the collar. These galls are often covered with many fine roots giving them a hairy appearance. Such growths have been reported on a number of plants which are closely related to the apple and also on other plants which are not closely related.

In the earlier studies of this disease the cause was not understood. Injuries to the roots and unfavorable conditions of soil and moisture were advanced as causes of the trouble. Experiments were carried on in a number of places, however, which demonstrated that the disease is communicable. In 1900, Toumey* published an account of his studies of crown gall in which he reports the results of extensive inoculation experiments. He concludes that the disease is infectious and is caused by a slime mold. The nature of this organism made impossible the use of pure cultures in inoculations.

More recently Smith** and Townsend† have studied crown gall on a number of plants and they have been able to prove quite conculsively that at least a part of the crown gall of the apple is of bacterial origin, caused by the organism *Pseudomonas tumefaciens* Erw. Smith and Townsend.

The organism was first isolated from galls on the Paris daisy and inoculations showed that it could produce the disease. Inoculations of tomato, tobacco, potato, sugar beet, grape, carnation, raspberry, peach and apple were also followed by the development of galls. This led to the isolation of organisms

* Toumey, J. W. Ariz. Exp. Sta. Bul. 33: 1-64. 1900.

** Smith, Erwin F. and Townsend, C. O. A Plant Tumor of Bacterial Origin. Science, N. S. 25: 671-673. 1907.

† Townsend, C. O. A Bacterial Gall of the Daisy and Its Relation to Gall Formation in Other Plants. Science, N. S. (Abstract) 29: 273. 1909.

from the galls of peach, hard galls of apple, hairy root of apple, hops, rose, and chestnut, which were found to be very similar if not identical with the organism from the daisy.

The fact that crown gall of the apple is now definitely known to be caused by a parasite which also causes galls of a number of other plants is of great importance in the control of the disease. It will be readily seen that young apple trees should not be set in land on which another plant affected with this disease has been grown.

In the apple, the greatest amount of infection is likely to take place in nursery stock, as the trees are grown rather closely in the nursery row. When affected trees are set in the orchard, new galls develop from year to year and in many cases the trees weaken and die. Little good is accomplished by cutting off the galls at the time of setting the trees, as it is practically impossible to remove all of the infected tissue and new galls develop. It is best to secure apple trees from nurseries which are free from the disease, but in case diseased trees are received they should be destroyed. In the cultivation of orchards in which trees affected with this disease are known to occur, care should be taken that healthy trees do not become infected through injuries near the surface of the ground.

Wood destroying fungi. It is a well known fact that the heart wood of apple trees is often decayed. In many cases the extent to which the wood has been destroyed is not realized by the owner of a tree until it is blown over by a heavy wind and it is found that only a thin shell of sap wood remains. Such a condition is shown in Fig. 265.

It is not so generally understood by orchardists that this decay is caused by the growth of fungi. In some cases the mycelium of a fungus may grow on the interior of a tree for years before there is much evidence of its growth on the outside. Then after the mycelium has stored up a sufficient amount of food, the fungus produces its fruit. In many cases these wood destroyers belong to the bracket or shelf fungi of which a number of species have been reported on the apple. Very frequently the wood of apple trees is badly decayed before the fungus fruits and then it is too late to apply a remedy to the tree.

Wood destroying fungi enter the wood of trees through wounds which may be caused in various ways. Some of the

common ways are barking by machinery in cultivation and injuries by such animals as rabbits and mice, and by borers. Broken or improperly pruned branches make a good place for the entrance of fungi. A broken, splintered branch which will hold moisture makes an excellent place for the germination of spores and the mycelium after it has grown for a time under favorable conditions is able to penetrate the wood. Care should be taken to remove all such broken and splintered branches and in removing them long stubs should not be left which will be slow in healing over if they heal at all. In pruning the branch should be cut back as close to the larger branch or trunk as possible, and the surface of the wound should be parallel and as near as possible on line with the surface of the main trunk or branch. Such a wound if protected will heal over without injury to the tree, while even a short stub will never do this, although the wound made is much smaller. Much of the heart rot is caused by fungi which gain entrance through stubs left by improper pruning. When it is necessary to remove large branches, the wound should be painted or otherwise protected.

Wood destroying fungi may also enter the wood through places in the bark injured by canker fungi and by frost. Here again may be emphasized the necessity of attending promptly to the treatment of all wounds of whatever origin, as the control of wood destroying fungi must be a matter of prevention and not of cure.

Orchard Sanitation, Sprays and Spraying.

From the foregoing pages it will be seen that all attempts at the control of fungous pests of the orchard must in a large degree be directed toward the application of preventative rather than curative measures. While spraying is beneficial and should be practiced by all, it should be supplemented by thorough orchard sanitation. No dead or diseased limbs, cankers, or mummified fruit should be allowed to remain on the trees or in the orchards. Particular attention should be given to the removal and destruction, by burning, of all rubbish, litter, decaying wood or fruit which might serve as breeding places for fungi or for insects. The good effects of cultivation in the orchard are by no means confined to those which tend to make available the food supplies contained in the soil and to the conservation of

moisture. It also assists materially in the control of the fungous and insect pests of the orchard, particularly the latter.

As has already been pointed out (p. 340), the vegetative portions of the fungi causing disease are deep within the tissues of the plant beyond the reach of destruction. Hence sprays are of value largely to prevent the entrance of parasites into the healthy tissues and not as agents to kill them after they have once gained entrance. To be successful the spray must be on the fruit or foliage in advance of the spore of the fungus.

For many years bordeaux mixture has been practically the only spray used on orchard trees for the control of fungous diseases. While it has proven in every way efficient in controlling most of the destructive fungous diseases of the orchard, it has been found that the fruit and foliage of certain varieties of apples are frequently injured by the spray. As a rule the beneficial effects resulting from disease control have far outnumbered the ill effects of spray injury. That certain varieties of apples are susceptible to spray injury, or bordeaux injury as it is frequently called, especially if rainy, damp or cloudy weather is experienced at or immediately following the application of the spray, has been held responsible in a considerable measure for the lack of more general adoption of spraying by Maine orchardists. In too many cases the fact that many varieties (see list on p. 346) are seldom, if ever injured by bordeaux mixture has been entirely overlooked. Neither has it been understood that the danger from bordeaux mixture can be minimized largely, in many seasons, by applying the spray only during periods of bright, sunny weather, and avoiding its use, if possible, when there are several, successive, cloudy, rainy days.

However, there has been and is a demand for a fungicidal spray which will control the various plant diseases and still cause no injury to the foliage and fruit of the more tender varieties. Experiments begun by Scott* in spraying apples and peaches, the latter being very susceptible to bordeaux injury, and later taken up by others in various parts of the country, indicate that in the different lime-sulphur sprays we have the promise of something which may control certain of our orchard diseases nearly if not quite as well as bordeaux mixture and if not used

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* Scott, W. M. Self-boiled Lime-sulphur as a Promising Fungicide. Bureau Pl. Ind., U. S. D. A., Cir. 1, pp. 1-18. 1908.

too strong be practically free from the production of spray injury.

Therefore, it is recommended that all orchardists who have experienced trouble with bordeaux injury in the past, and others who wish to spray varieties which are known to be susceptible to spray injury, give the lime-sulphur treatment a thorough trial. It will be noted, however, that lime-sulphur as suggested for summer spraying for fungous diseases is used in a much more diluted form than for winter spraying for insect pests. The more concentrated sprays are far too strong to be used on the tender foliage and fruit.

The above recommendation should in no way be construed as advising against the use of bordeaux mixture where it has always been used without injury in the past or with those varieties of apples which the experience of others indicates that there is little or no danger of bordeaux producing any injurious effects on the fruit or foliage. Apple scab is the greatest factor to be considered in Maine orchard spraying, and in the experience of the writers bordeaux is, as a rule, more effective than lime-sulphur in controlling this disease under the weather conditions which prevail in this State. There is no reason for discarding bordeaux for lime-sulphur except to attempt to avoid spray injury on those varieties of apples upon which it is likely to occur. Even with these it is recommended that bordeaux mixture still be used for the first spraying before the buds open, followed by lime-sulphur for the later sprayings upon the foliage and fruit. If, however, the orchard has received a spring application of the more concentrated lime-sulphur wash for insects before the buds begin to swell, the early application of the bordeaux is probably unnecessary.

THE PREPARATION OF SPRAYS.

There is no part of the management of an orchard which requires more intelligent and careful work than the preparation and use of sprays. If the owner cannot attend to this part of the work himself he should put it in charge of some thoroughly competent person. Many failures from spraying have resulted from the fact that the sprays were not properly made and applied. The formulae given should be followed with care, the operator first satisfying himself that he understands each step

of the process before attempting to prepare a quantity of spraying material. All material should be carefully weighed and measured.

BORDEAUX MIXTURE, FORMULA I.

Copper sulphate (blue vitriol)......	3 pounds
Fresh stone or lump lime..........	3 "
Water	50 gallons

It will be noted that the bordeaux mixture here recommended is only three-fifths as strong as that commonly used on potatoes in this State and formerly recommended by this and other Stations for use upon the apple. This is because later work has shown that the weaker bordeaux controls the apple scab nearly as well and is much less likely to injure the fruit and foliage than the stronger. The 5-5-50 formula should still be used upon potatoes, and upon apple trees before the buds open.

Metal vessels should not be used in the preparation of bordeaux mixture. Empty kerosene barrels with one head removed (50 gal. capacity) are more commonly used, but larger wooden tanks are frequently employed. For convenience these should hold multiples of 50 gallons, or have the capacity in 25 or 50 gallon units indicated by tacking a short, thin strip of wood at the required height on the inside of the tank.

Slake the lime and dissolve the copper sulphate in separate barrels and then dilute each with half of the water. It is necessary to strain the milk of lime solution after slaking.* This

* The most satisfactory strainer that the writers have ever used is constructed as follows: Make a box about 12-15 inches long, without ends and just small enough to slide easily inside the top of the dilution barrel. Then one end of the box is sawed off at a considerable angle, making one side much shorter than the other. No. 50 brass wire strainer cloth is then tacked securely over this end. (Pieces of discarded wire screen cloth used on the machines in paper mills are excellent for this purpose but are of somewhat finer mesh). Two pieces of board about 2 inches wide, and long enough to reach across the top of the barrel are then nailed to the sides close to the other end. The completed strainer is then placed in the top of the dilution barrel with the wire bottom down and the two cross pieces extending across the top of the barrel and serving as supports. With a little care such a screen never troubles with clogging as the wire bottom is placed at such an angle that the solid particles are continually washed to the lower side of the screen leaving the remainder unclogged.

is best done in making the dilution by using a separate barrel for this purpose and using the dilution water to wash the material through the strainer. If the lime is of good quality and well slaked most of it will pass through the strainer, but with the best there will be a slight residue which may be thrown away. If arsenate of lead is to be added to the bordeaux as an insect poison the required quantity may be wet up and washed through the strainer with the lime.

When ready to use the mixture, the dilute lime and copper sulphate solutions are quickly mixed together and thoroughly stirred. This may be done by rapidly dipping up a pailful of one and then a pailful of the other solution and pouring into the mixing or spray tank while a second person agitates the mixture. *Never pour concentrated milk of lime and copper sulphate solutions together.* The above procedure is recommended only where a single barrel or at the most only a few barrels of spray mixture are needed at a time. Where any quantity of bordeaux is required stock solutions and, if possible, the elevated mixing platform should be resorted to.

Stock solutions. When lime and copper sulphate are combined in the form of bordeaux the mixture should be used with as little delay as possible on account of deterioration. On the other hand, as long as the solutions are kept separate and covered to keep out rain and to prevent evaporation they may be stored for an indefinite period. Hence concentrated stock solutions of lime and copper sulphate may be prepared, at any convenient time, sufficient for one application to the entire orchard or for the entire season if the orchard is not too large. Stock solutions are made up so that each gallon when thoroughly stirred carries a known amount of lime or copper sulphate as the case may be—as a rule either one pound or two pounds to the gallon.

If it is intended to make stock solutions carrying one pound to the gallon place 50 pounds of fresh stone lime in a 50-gallon cask, slake, dilute to thin whitewash, strain while hot and make up to 50 gallons. If arsenate of lead is to be used with the spray the proper amount may be wet up and washed through the strainer with the dilution water. *Always stir thoroughly, taking particular care to get to the bottom of the cask, before dipping out any of this stock solution,* otherwise the first will

carry less than a pound to the gallon and the last more. In another 50-gallon barrel suspend 50 gallons of copper sulphate crystals in a sack close to the top, and then fill the barrel with water. The copper sulphate suspended in this way will dissolve in a few hours, or over night, while if it is placed in the bottom of the barrel it will dissolve with difficulty unless the solution is constantly stirred. Some prefer to make stock solutions carrying 2 pounds of lime or copper sulphate to the gallon. In that case use 100 pounds of material instead of 50 in each 50-gallon barrel.

To prepare the mixture from the stock solutions, assuming that they carry a pound to the gallon and a 3-3-50 bordeaux is to be made, stir thoroughly and for each 50 gallons of spray dip out 3 gallons of the lime stock into one dilution barrel and 3 gallons of the copper sulphate stock into another, add water to make up to 25 gallons each, then quickly and thoroughly mix. If the stock solutions carry 2 pounds of material to the gallon use 1½ gallons of each to 50 gallons of mixture.

Elevated mixing platform. Much of the labor of making bordeaux may be avoided, and better facilities furnished for securing a perfect mixture by the use of the elevated mixing platform. This requires four solid posts resting on flat stones or set in the ground and extending above the surface somewhat above the top of the spray tank, to form the supports of the four corners of the platform. These posts should be solidly braced by means of crossed boards nailed from one to the other. To the tops of the posts on the outside around the four sides, pieces of 2x6 or equally strong material are spiked with the edges up—these to serve as sills. Other cross sills may be necessary for added strength, varying with the size of the platform. Lastly a floor of good sound plank is laid over the sills. The size of the platform varies somewhat with the location and needs of the user, but it should be large enough to accommodate the barrels for the stock solutions and dilution barrels, and leave sufficient room to move about, 10x12 feet is large enough for most places. Fig. 266 shows the platform in use at Highmoor Farm. The higher platform with the large tank is for water storage.

The dilution vessels should be large enough so that both together will contain enough liquid to fill the spray tank. That is, for a 100-gallon tank 2 50-gallon casks will be required for

dilution purposes. For a 200-gallon tank 4 50-gallon casks may be used. The dilution barrels are placed on the extreme front edge of the platform. A hole should be bored in a stave close to the bottom of each of these barrels. This hole should be large enough so that at this point a piece of rubber tubing of an inch or more internal diameter can be attached. The attachment may be made by screwing a short piece of brass pipe into the hole in the stave and sliding the rubber tube over the portion that projects outside. For added security against leaking a brass lock-nut with rubber washer may be screwed up against both inside and outside of the stave if the hole is not too close to the bottom. The rubber tubing should be long enough to reach well above the top of the dilution barrels and while the latter are being filled the free end should be held by means of a string tied around the tube near the end and hooked over a nail driven into the top end of one of the staves.

When the dilution barrels are filled the spray tank is driven alongside the platform, as close to them as possible. Standing on the spray tank the operator removes the free ends of the tubes from their support and inserts them quickly in the opening in the top of the spray tank. In this way the tank is rapidly and easily filled, and the best possible conditions supplied to secure a high grade mixture. In Fig. 266 the hose from the two barrels on the right are let down as in filling the spray tank. On the next barrel to the left the hose is hooked up as already described. In place of the hose large iron or brass faucets may be screwed to the bottom of the barrels and so arranged that they will open into a common conductor leading to the spray tank. However, on account of the corrosive action of the mixture the iron faucets will soon rust out.

Where running water is available it may be conducted to the platform with a garden hose or a metal pipe may be used, so arranged that it may be taken down or emptied before cold weather. Where running water is not available the platform may be erected alongside of a well, cistern, stream or pond. A cheap iron pump is placed on the platform, high enough so it will deliver over the tops of the barrels and connected with the water supply with a lead pipe.

BORDEAUX MIXTURE WITH IRON STICKER, FORMULA 2.

Copper sulphate (blue vitriol)......	2 pounds
Iron sulphate (copperas)..........	2-4 "
Fresh stone or lump lime..........	4-6 "
Water to make....................	50 gallons

This formula is proposed and recommended by Dr. A. D. Selby of the Ohio Experiment Station. It has not been used by the writers in Maine, but Doctor Selby makes the following statement with regard to it: *

"In this spray the iron sulphate is added in order that it may be precipitated by the lime and serve as a more complete sticker than is provided by standard bordeaux mixture. It would appear possible by the weak solution as given for the copper compound and by this possible efficient sticker to make the reduced amount of the copper sulphate do the work as fungicide just as effectively and with less risk of foliage injury than with standard bordeaux mixture. Trials made up to this time upon apples in full foliage, upon grapes, and upon potatoes indicate that the spray is efficient. *The iron sulphate is not considered a fungicide.*"

Where spray injury upon apple trees is experienced and the orchardist does not wish to go to the trouble of preparing his own lime-sulphur sprays or go to the expense of purchasing the prepared brands of lime-sulphur, a trial of this modified form of bordeaux mixture is suggested.

Lime-sulphur sprays. The orchardist who desires to use lime-sulphur compounds for summer spraying may choose one of the following: a self-boiled lime-sulphur, a home-cooked, or a factory-cooked concentrated material which must be diluted before it is applied. The first is comparatively easy to prepare but less effective than the other two. The home-cooked concentrated may be prepared some time before needed and later diluted as fast as required for use. It has the disadvantage of being somewhat more difficult to prepare, requiring some form of cooker and other pieces of apparatus. Of the factory-cooked concentrated material there are several brands on the market which seem to equal the home-cooked in efficiency and in freedom from the production of spray injury if used in sufficient

* Selby, A. D. Ohio Exp. Sta. Bul. 214, p. 358, 1910.

dilution. On the other hand, the commercial brands of lime-sulphur are, of necessity, the most expensive. This is partly offset in the saving in time and trouble in preparing the material. All that is necessary to do with these commercial brands is to dilute and apply.

Self-boiled lime-sulphur. The self-boiled lime-sulphur is the least effective in controlling apple scab according to the experience at this Station, but to prepare it requires no more apparatus or skill on the part of the maker than in preparing bordeaux mixture.

SELF-BOILED LIME-SULPHUR, FORMULA 3.

Sulphur	10 pounds
Fresh stone or lump lime..........	10 "
Water	50 gallons

To be applied without farther dilution.

The following is the method of preparation as described by Scott* and as used by the writers in the experiments mentioned on p. 349:

"The mixture can best be prepared in rather large quantities —say 20 pounds, or even 40 pounds at a time—so as to get enough heat to produce a violent boiling for a few minutes. Place the lime in a barrel and pour on enough water (about 3 gallons to 20 pounds) to start it slaking and to keep the sulphur off the bottom of the barrel. Then add the sulphur, which should first be worked through a sieve to break up the lumps, and finally enough water to slake the lime to a paste. Considerable stirring is necessary to prevent caking on the bottom. After the violent boiling which accompanies the slaking of the lime is over, the mixture should be diluted ready for spraying, or at least enough cold water added to stop the cooking. Five to fifteen minutes are required for the process, according to whether the lime is quick acting or sluggish. The intense heat seems to break up the particles of sulphur into about the physical condition of precipitated sulphur and the violent boiling makes a good mechanical mixture of the lime and sulphur. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into solution, but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the

* Scott, W. M., Bureau Pl. Ind., U. S. D. A., Cir. 27, p. 5, 1909.

lime, and at the end of thirty or forty minutes enough of the reddish liquid is produced to burn peach foliage in some cases. Hence the necessity for cooling the mixture as soon as the lime is well slaked. The finely divided sulphur in mechanical mixture with the lime is depended upon for the fungicidal action rather than the sulphide in solution, the latter being harmful to foliage except in very dilute form."

The mixture must be strained and particular care taken to wash all of the particles of sulphur through the strainer. The form of strainer, with the sharply inclined bottom, described in the foot-note on p. 380, is very satisfactory for this porpose. Maine lime is rather slow to heat up but slakes well and thoroughly after it is once started. Therefore, when employed for this purpose a few dippers of hot water may be used at first to start the lime off briskly. If all hot water is used there is some danger of bringing too much sulphur into solution and injury tc the foliage results when applied to the more tender varieties. The diluted mixture may be kept for a week or more without deterioration. On account of the character of the mixture great care must be taken to see that it is constantly and thoroughly agitated while being applied. Otherwise much of the suspended sulphur will settle to the bottom.

Home-cooked concentrated lime-sulphur. For the average farmer using only a small quantity it is probably wiser to purchase the factory-cooked concentrated material for dilution than to attempt its manufacture himself. However, in the case of large orchards where the expense for the ready-made article would be large or where the user has had some experience or training in similar lines of work its preparation may well be attempted. Before doing so it would be well to obtain and read Bulletin 99 of the Pennsylvania Station, State College, Pa., and Bulletin 320 of the New York Station, Geneva, N. Y. A kettle or some form of cooker is necessary and, whether one prepares his own concentrate or buys the ready prepared, some form of specific gravity apparatus as the Baumé hydrometer for testing the strength of the concentrated mixtures is essential. These latter may be obtained from various dealers in scientific apparatus. Those used by this Station were purchased of the Bausch & Lomb Optical Co., Rochester, N. Y. A pamphlet describing their use comes with the instruments, or may be obtained free

on request. The cost for the complete hydrometer outfit need not exceed $1.00 to $1.25.

Professor Whetzel and his associates at Cornell University as the result of their studies and experiments have done much to stimulate interest in this class of fungicides. The following method of preparing the concentrated mixture is adapted from a paper read by Professor Whetzel before a recent meeting of the New York State Fruit Growers' Association, and is based on the recommendations of Professor Cordley of the Oregon Station, who has probably done more than any one else to develop lime-sulphur spraying for fungous diseases, especially on the Pacific coast.*

HOME-BOILED CONCENTRATED LIME-SULPHUR, FORMULA 4.

Sulphur (best finely ground).......	110 pounds
Fresh stone or lump lime...........	55 "
Water to make....................	60 gallons

Caution. *Must be greatly diluted for use on apple foliage, see below.*

Slake the lime in the kettle, make a paste of the sulphur with a little water, then add this paste and the remainder of the water to the lime solution in the kettle. Boil 30-45 minutes or until the sulphur is dissolved and then after the sediment has been allowed to settle pour off the clear, amber liquid which should be approximately 45 gallons and test about 30° Baumé. The liquid may test higher or lower than this, varying with the concentration, so it should always be tested. *The liquid should not be tested while hot but should be cooled to about 60° F.* The reading on the hydrometer should be taken at the general surface of the liquid at which it is supported.

If the concentrate is not intended for immediate dilution it should be at once stored in tightly closed containers till ready for use. The amount of dilution will, of course, depend upon the density of the concentrate. The following table supplied by Cordley gives the amount of dilution of concentrated lime-sulphur stock solutions of different degrees of density according to the Baumé scale for winter and summer spraying of apple trees. Only the dilutions indicated in the right-hand column should be used for trees in leaf.

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* Cordley, A. B. Oregon Exp. Sta. Bul. 108, p. 16, 1910.

TABLE FOR DILUTION OF CONCENTRATED STOCK SOLUTIONS OF VARYING DENSITIES.

Stock Solution Baumé Scale Reading.	Winter Strength Leaves Off. Dilution.	Summer Strength Leaves On. Dilution.
32°	1-12	1-30
31°	1-11	1-29
30°	1-10	1-28
29°	1-9½	1-27
28°	1-9	1-26
27°	1-8½	1-25
26°	1-8	1-24
25°	1-7½	1-23
24°	1-7	1-22
23°	1-6½	1-21
22°	1-6	1-20

Not counting the initial cost of the apparatus it is estimated that at the prevailing price of labor and materials home-made, concentrated lime-sulphur can be prepared for from $3.00 to $3.50 per barrel of 50 gallons. If the fact that 50 gallons of concentrated material will when diluted for summer use make from 1300 to 1500 gallons of spray, is remembered, it will be seen that home-cooked lime-sulphur is considerably less expensive than bordeaux mixture.

Commercial concentrated lime-sulphur. During the past two years several firms have placed on the market different brands of concentrated lime-sulphur similar to the home-boiled article. Quite a number of these have been tested experimentally and as a rule these have given quite favorable results when compared with the latter. While directions may be furnished with the commercial brands, they should always be tested with the hydrometer and the dilutions made on this basis, using the table given above.

"Variations in the degree of concentration of the commercial lime-sulphur mixtures may occur with different barrels of the same brand. Some companies compounding these sprays have apparently not been able to produce a wash of definite strength or have failed to realize the importance of maintaining a uniform grade for their product."*

* Parrot, P. J., N. Y. Exp. Sta., Bul. 320, p. 423, 1909.

All other things being equal, an article testing rather high and relatively free from sediment would be the more economical to buy. Hydrometers do not detect soluble impurities added to lime-sulphur concentrates for the purpose of increasing their densities. The national law against the adulteration of fungicides and insecticides will doubtless prevent this difficulty, but if there is any reason to suspect the character of any brand of goods a sample should be submitted to a chemical examination.

Before buying any of these concentrated sprays the purchaser should *make sure that it is a lime-sulphur compound.* At least one other concentrated substitute for bordeaux the name of which indicates that it is some sort of a soluble sulphur preparation has been known to produce disastrous results when applied to apple trees with arsenate of lead in even greater dilutions than recommended by the manufacturers.

Dust sprays. In hilly, rocky orchards where heavy spraying machinery can be hauled with difficulty, and in localities where a plentiful, near-by supply of water is not available, spraying with liquid sprays is attended with considerable difficulty. To meet this difficulty various dry sprays, said to contain approximately the same active constituents as liquid bordeaux mixture, have been advocated from time to time. These are in the form of a very fine powder to be blown forcibly on to and within the foliage by means of specially designed machines, the essential parts of which consist of a rapidly rotating fan, a hopper to hold the powder, and a line or lines of hose to conduct the air blast carrying the powder up among the tree tops.

In some instances favorable results have been reported for the dust sprays, but in the opinion of the writers their use is not advisable. In 1907 one of us (M.) demonstrated the marked inferiority of the dust sprays as compared with standard 5-5-50 liquid bordeaux for the control of the late blight of the potato.* At the same time the late Prof. W. M. Munson of this Station was conducting experiments with dust sprays on apple trees for scab. While these results were never published they were in general similar to those secured on potatoes. Crandall has, however, made and published the results of a very thorough study of the relative merits of liquid bordeaux and

* Morse, W. J. Me. Agr. Exp. Sta. Bul. 149, p. 289, 1907.

dust sprays for orchards in Illinois. The following paragraph is a concise summary of his conclusions.*

"The results of the experiments are sufficiently decisive to warrant the conclusion that the dust spray is absolutely inefficient as a preventative of injury from prevailing apple fungi, and that it is considerably less efficient as an insect remedy than is the liquid method of applying arsenites."

WHEN TO SPRAY AND WHAT TO USE.

If supplemented with proper orchard sanitation apple scab and practically all of the other serious fungous diseases of the fruit and foliage of Maine orchards may be quite successfully controlled by the following procedure:

Apply the first spray when the leaves are unfolding, the second immediately after the blossoms fall and the third 10 days or two weeks thereafter. If the season is very wet a fourth spraying after another interval of 10 days or two weeks may be necessary.

For varieties resistant to spray injury use 3-3-50 bordeaux mixture, Formula 1. For more tender varieties self-boiled lime-sulphur, Formula 3; home-cooked lime-sulphur, Formula 4, diluted to summer strength, or commercial brands of lime-sulphur diluted to summer strength, are suggested. Where scab is very prevalent or spraying has been neglected in the past it is advisable to substitute for the first spraying with lime-sulphur an application of 5-5-50 bordeaux made a little earlier in the season before the leaf buds open. It is claimed by those who have experimented with home-cooked or commercial lime-sulphur diluted to winter strength and applied just before the leaf buds open that they are also very effective in killing the spores of fungi on the twigs in addition to destroying scale and other insects.

Insecticides with fungicides. When applying the fungicides described above it is advisable to add some form of poison to the first two or three applications after the leaves begin to show, to kill the bud moth, canker worm, tent caterpillar, forest caterpillar, etc. Paris green and lead arsenate are both effective but for several reasons the latter is preferred by many for use on apple trees. One to three pounds of lead arsenate to 50 gallons

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* Crandall, C. S., Ill. Exp. Sta. Bul. 106, p. 240, 1906.

of bordeaux mixture or lime-sulphur may be used. In the case of lime-sulphur it should not be added till it is diluted ready to apply. In experimental work and in the dryer climates of some Western states one pound of lead arsenate has been found to be sufficient for 50 gallons of spray, but in practice with average farm conditions two to three pounds are usually required.

HOW TO SPRAY.

To do really good and effective work in orchard spraying requires constant care and watchfulness on the part of the operator, and also requires a certain amount of practice to secure the best results. Thoroughness is very essential, but by thoroughness is not meant drenching the tree. The spray should be delivered with a constant, strong pressure, issuing from the nozzle in a fine mist, the finer the better. The operator after a little experience will find that if he moves the extension rod carrying the nozzles at the proper rate and the right distance removed from the leaves he is enabled to cover them thoroughly with a fine mist-like coating, provided the proper type of nozzle is used, and there is no tendency for the mixture to gather together in large drops on the leaves or drip off from the edges. While avoiding applying enough of the spray to cause dripping care should be taken to reach the foliage and limbs on all parts of the tree. It is impossible to do thorough spraying in trees which have not been properly pruned and in which the tops are filled with water-sprouts and interlocking branches.

SUBJECT INDEX.

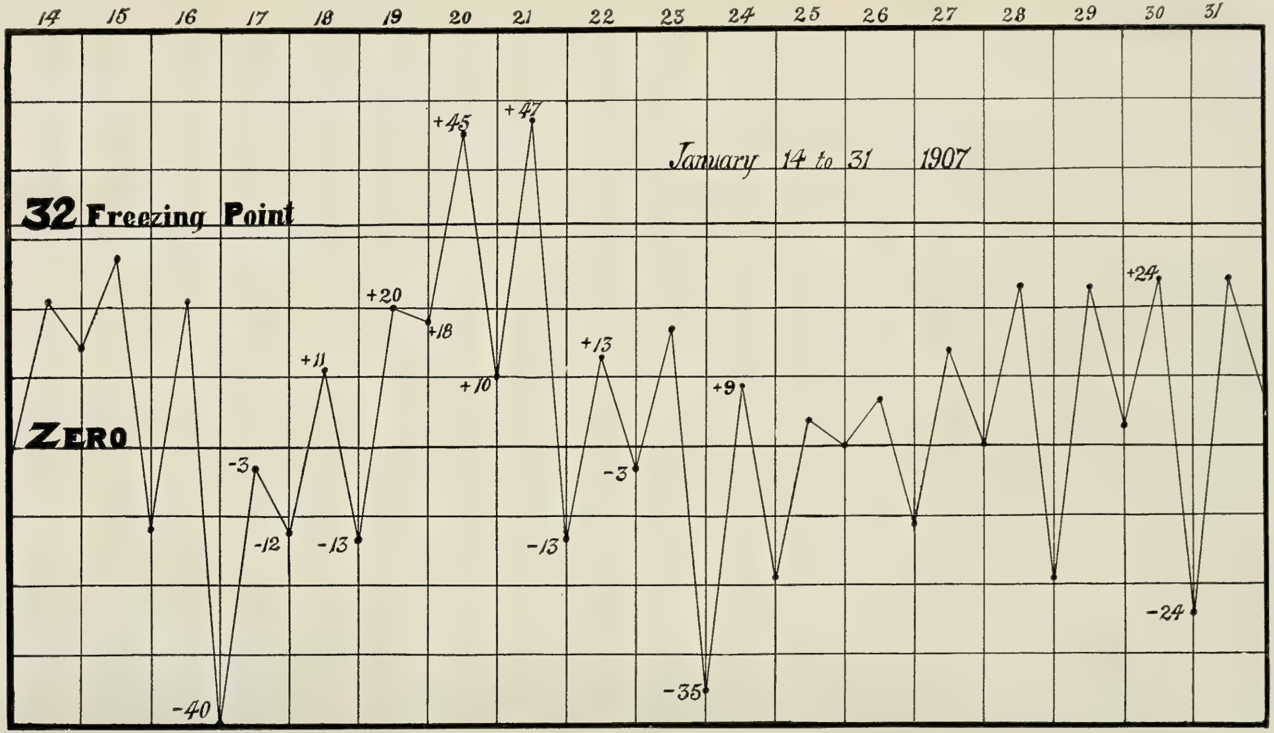

Fig. 237. Maximum and minimum temperatures in degrees F., Orono, Me., Jan. 14-31, 1907.

Fig. 238. Crotch injury of apple tree.

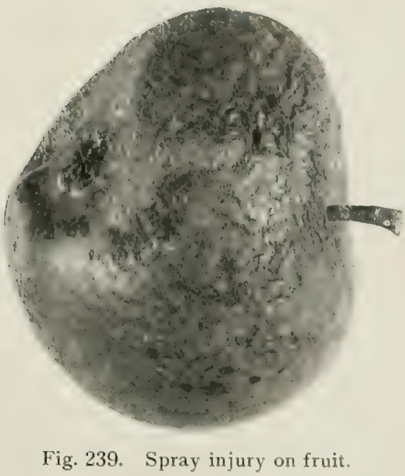

Fig. 239. Spray injury on fruit.

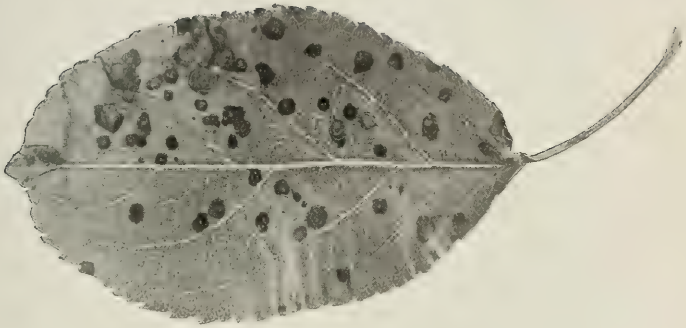

Fig. 240. Spray injury on leaves.

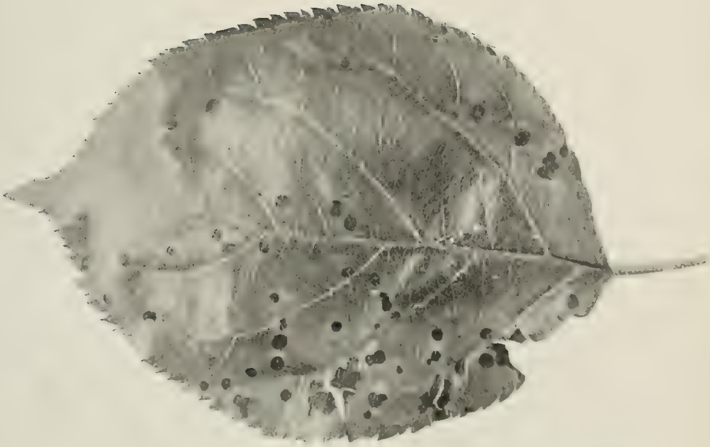

Fig. 241. Spotting of leaves by fungus.

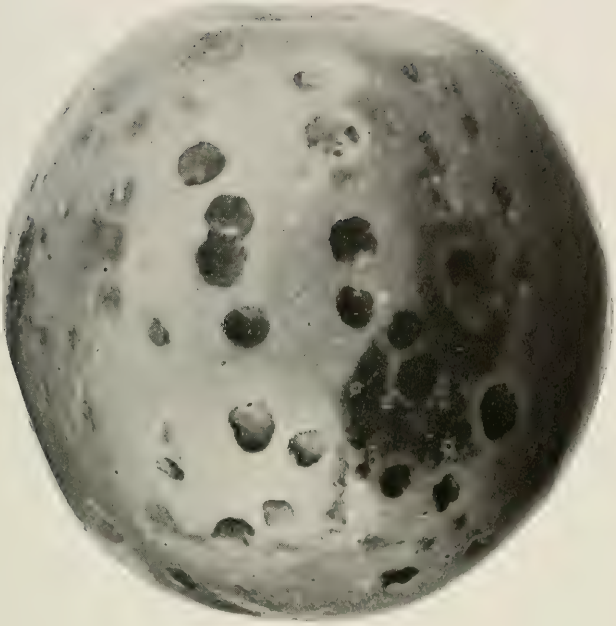

Fig. 242. Baldwin spot.

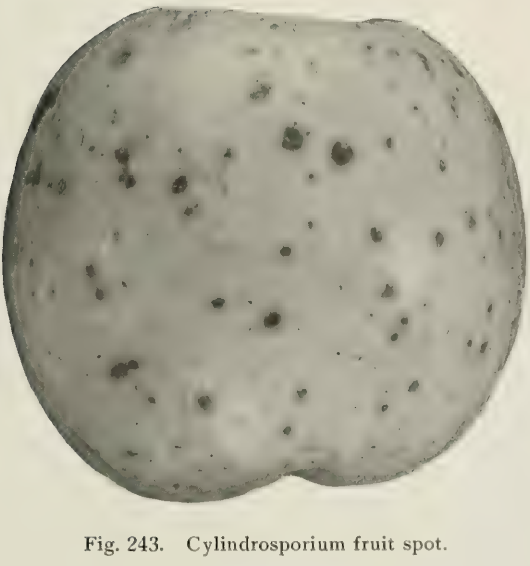

Fig. 243. Cylindrosporium fruit spot.

Fig 244. Lichens on an apple branch.

Fig. 245. Malformation and cracking resulting from a bad attack of scab. The surface of the fruit is nearly covered with scab spots.

Fig. 246. Scab developed in storage.

Fig. 247. Scab on apple leaves.

Fig. 248. Powdery mildew on apple leaves.

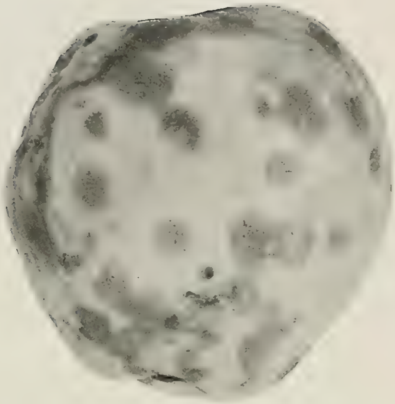

Fig. 249. Sooty blotch.

Fig. 250. Black rot.

Fig. 251. Blue mold decay.

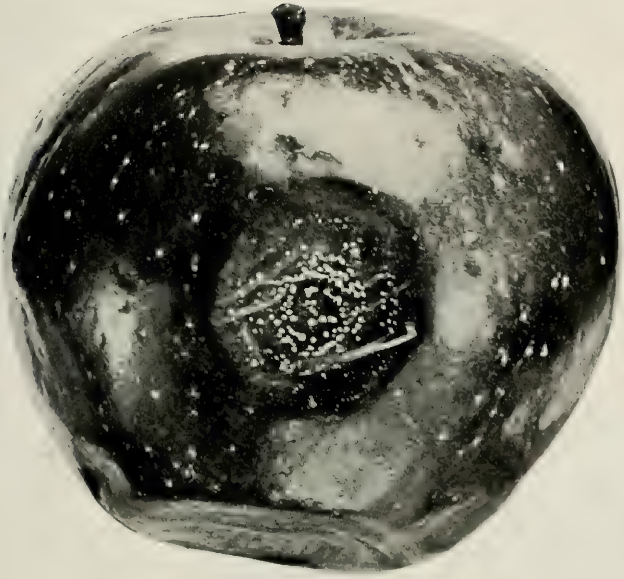

Fig. 252. Bitter rot.

Fig. 253. Brown rot resulting from artificial inoculation.

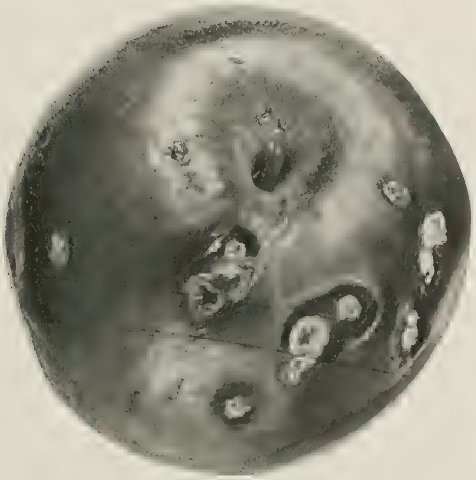

Fig. 254. Pink rot following scab.

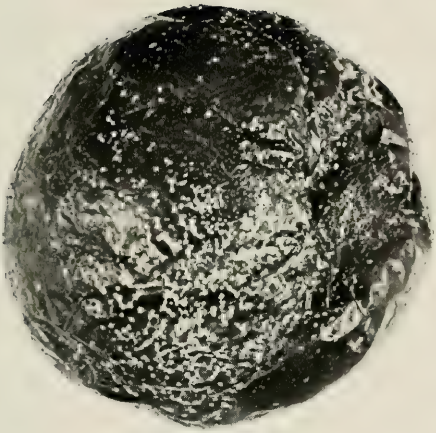
Fig. 255. Phoma decay.

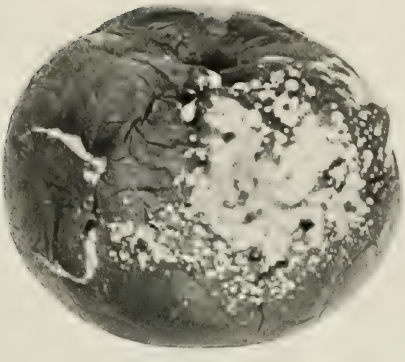
Fig. 256. Fusarium decay.

Fig. 257

Fig. 258

Fig. 259

Different stages in the formation of Sphaeropsis limb cankers.

Fig. 260

Bitter rot. Stem of young tree, one month after inoculation with fungus.

Fig. 261

Myxosporium twig-blight

Fig. 262

Fig. 263

Fig. 264

Coryneum. Fig. 262. Branch 3 months after inoculation. Fig. 263. Young canker produced naturally. Fig. 264. Twig blight, caused by Coryneum.

Fig. 265. Decay of the heart-wood resulting from fungus infection of surface wounds

Fig. 266. Elevated platform, at the right, for preparing Bordeaux Mixture. The larger tank on the higher platform is for water storage.

METEOROLOGICAL OBSERVATIONS.

Lat. 44° 54′ 2″ N. Lon. 68° 40′ 11″ W. Elevation 150 feet. The instruments used at this Station are the same as those used in preceding years, and include: Wet and dry bulb thermometers; maximum and minimum thermometers; rain-guage; self-recording anemometer, vane, and barometer. The observations at Orono now form an almost unbroken record of forty-two years.

METEOROLOGICAL SUMMARY FOR 1910.

Observations Made at the Maine Experiment Station.

1910.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.	Total.
Highest temperature	53°.0	45°.0	73°.0	71°.0	76°.0	87°.0	91°.0	85°.0	80°.0	78°.0	56°.0	47°.0		
Lowest temperature	-17°.0	-23°.0	4°.0	21°.0	26°.0	31°.0	43°.0	36°.0	31°.0	21°.0	15°.0	-18°.0		
Mean temperature	22°.35	19°.15	36°.15	47°.15	53°.40	61°.65	69°.20	65°.05	58°.40	48°.40	34°.95	19°.55	44°.62	
Mean temperature for 42 years	16°.35	18°.87	28°.20	40°.81	52°.48	61°.96	67°.10	65°.05	57°.53	45°.23	34°.36	20°.58	42°.37	
Total precipitation in inches	3.57	3.42	1.91	2.76	1.42	2.70	2.43	3.72	2.79	2.56	1.52	2.88	....	31.68
Mean precipitation in 42 years	4.26	3.86	4.21	2.92	3.44	3.45	3.22	3.44	3.50	3.81	3.63	3.67	....	43.41
No. of days with precip. of .01 in. or more	8	9	7	15	12	13	8	11	8	12	10	11	....	124
Snow fall in inches	11	23.5	1.0	Trace.	....	....	....	....	....	Trace.	4.25	12.50	....	52.25
Mean snow fall in 42 years	22.7	21.2	15.9	5.5	0.23	....	....	....	....	0.78	7.7	16.8	....	90.80
Number of clear days	11	9	13	10	5	5	13	17	6	8	3	11	....	111
Number of fair days	5	6	5	5	10	10	10	7	12	8	7	6	....	91
Number of cloudy days	15	13	13	15	16	15	8	7	12	15	20	14	....	163
Total movement of wind in miles	5365	5432	5555	5496	5285	4387	4419	3949	4192	5489	5455	4788	....	59812

Monthly and Annual Precipitation (as rain) for the Year 1910.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Bar Harbor	3.30	5.40	3.10	5.17	1.75	4.15	1.00	2.65	1.12	1.01	2.00	4.25	34.90
Cornish	4.25	5.19	1.76	4.90	1.68	3.39	1.64	3.53	3.40	2.04	2.62	3.42	37.82
Eastport	3.80	4.52	1.98	3.42	1.55	2.72	1.92	1.44	1.84	1.85	2.14	3.68	30.86
Fairfield	2.19	2.95	1.71	2.37	1.77	1.99	2.26	1.46	2.04	1.10	1.53	2.90	27.27
Farmington	3.48	2.97	1.41	4.38	2.16	3.15	3.10	3.94	2.30	1.19	2.31	2.74	33.13
Gardiner	3.22	4.30	1.98	4.45	2.03	2.26	1.83	4.53	2.58	2.26	2.70	2.97	35.11
Greenville	3.43	3.51	2.18	2.51	4.65	5.31	4.18	3.69	2.77	2.13	3.21	2.64	40.21
Houlton	0.95	2.00	1.40	2.66	3.75	2.50	2.17	1.07	0.85	1.65	1.42	0.87	21.29
Lewiston	3.44	4.24	1.90	4.16	1.94	2.62	2.40	4.81	2.68	1.69	2.18	3.14	35.20
Madison	4.13	2.69	1.91	4.38	2.71	4.19	4.01	3.69	2.95	1.51	2.87	2.99	38.03
Millinocket	4.05	3.56	1.66	4.27	2.97	4.37	3.72	2.39	2.61	2.21	2.86	2.96	37.63
North Bridgton	3.77	4.48	1.65	4.92	3.20	3.28	1.35	5.72	4.15	3.13	2.51	3.63	41.79
Orono	3.57	3.42	1.91	2.76	1.42	2.70	2.43	3.72	2.79	2.56	1.52	2.88	31.68
Patten	3.10	3.34	0.93	5.35	6.68	4.28	4.27	2.28	4.63	2.98	2.36	2.73	42.93
Portland	2.90	4.84	1.62	4.12	1.65	3.26	1.64	2.79	2.89	1.27	1.85	3.43	32.26
Presque Isle	1.89	1.63	0.92	3.49	3.91	2.90	6.38	0.93	2.75	2.87	2.78	1.73	32.18
Rumford Falls	3.88	2.68	1.78	4.68	2.83	2.97	2.22	3.51	2.94	1.36	2.28	2.31	33.44
Winslow	3.12	2.41	1.86	3.14	2.67	4.10	2.90	5.52	2.51	1.46	2.43	2.78	34.90

With the exception of readings from the Orono station, the above table is compiled from the monthly bulletin of the U. S. Weather Bureau.

REPORT OF TREASURER FOR FISCAL YEAR ENDING JUNE 30, 1910.

RECEIPTS.	Hatch Fund.	Adams Fund.	General Account.	Inspections.*
Balance July 1, 1909	....	....	$1,137 83	$137 49
Treasurer of United States	$15,000 00	$13,000 00		
State	....	....	....	**4,500 00
Sales, etc	....	....	1,428 72	
Analysis fees	....	....	....	687 41
Total	$15,000 00	$13,000 00	$2,566 55	$5,324 90
DISBURSEMENTS.				
Salaries	$6,532 51	$11,666 19	$731 06	$3,826 40
Labor	1,282 21	160 00	27 10	
Publications	169 17			
Postage and stationery	447 32	....	47 42	126 23
Freight and express	402 17	14 42	20 52	38 91
Heat, light and power	256 12	....	337 94	133 33
Chemical supplies	38 15	....	....	286 23
Seeds, plants and sundry supplies	526 20	436 47	36 26	284 88
Fertilizers	358 22			
Feeding stuffs	1,096 60	24 19	276 65	
Library	616 94	191 32	66 40	
Tools, implements and machinery	535 82	....	5 45	
Furniture and fixtures	806 60	85 63	8 00	
Scientific apparatus	445 97	42 89	100 00	9 23
Live stock	616 68	5 00	13 54	
Traveling expenses	417 73	373 89	2 02	557 10
Contingent expenses	115 25	....	120 00	15 80
Buildings	336 34	....	10 00	
Balance, June 30, 1910	....	....	764 19	46 79
Total	$15,000 00	$13,000 00	$2,566 55	$5,324 90

* For the six months January 1 to June 30, 1910. Receipts and expenditures do not include what appear on the Station Books as January transactions, the explanation being that these were included in former report under December, 1909, business.

** Due but not paid July 1, 1910.

The classified report does not include $1,000.00 paid for services and feeding stuffs in poultry investigations by the U. S. Department of Agriculture, nor the annual appropriation of $4,500 from the State for printing Station publications.

INDEX.

INDEX TO REPORTS FOR THE YEARS 1906 TO 1910, AND TO BULLETINS 125 TO 186 INCLUSIVE.

In each reference the first two figures indicate the year. Thus, '10, 23 indicates page 23 of the report for 1910.

APPENDIX

Official Inspections.

19 to 28

TWENTY-FIFTH ANNIVERSARY EXERCISES.

CONTENTS.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

19

Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

FERTILIZER INSPECTION.

The law regulating the sale of commercial fertilizers in this State formerly called for the publication of two bulletins each year. The first of these, issued in the early spring, contained the analysis of the samples received from the manufacturer guaranteed to represent within reasonable limits the goods to be later placed upon the market. The second bulletin contained the analysis of the samples collected in the open market by a representative of the Station.

It had been found by long experience that the results of the analysis of samples collected by representatives of the Station are a safer guide in the purchase of fertilizers than those of the manufacturers' samples. The Legislature of 1909 changed the law relative to publication so that hereafter only one fertilizer bulletin will be published each year. It is planned hereafter to issue in January of each year the bulletin containing the reports of the analysis of the samples collected by the Station representatives of fertilizers sold in Maine during the preceding year.

Chief Requirements of the Law.

The law applies to "any material used for fertilizing purposes, the price of which exceeds ten dollars a ton." For many years the sale of materials other than mixed goods was so small that no notice was taken of it. As time went on, however, with the propagation of the ideas of home mixing, the demand for chemicals increased. For the last few years the most common chemicals such as acid phosphate, ground bone, nitrate of soda and the various potash salts are regularly licensed by the companies handling them. In the case chiefly of companies manufacturing in the State it happens that other fertilizing constituents are sold in small amounts and primarily for experimental purposes. While the law is explicit there will until further notice, be no prosecutions made by the Directors of the Maine Agricultural Experiment Station for the sale without license of small amounts of these more unusual fertilizing constituents, provided the company can show that these goods were sold in good faith for experimental purposes. As a part of the indication that the goods were thus sold it should be explained to the customer exactly under what conditions the goods are sold; that they are unlicensed; that they have not been or are not likely to be analyzed by the Director of the Maine Experiment Station and that the Director holds himself in no way responsible for the quality of these unlicensed goods sold for experimental purposes. Their sale is allowed because the Director does not regard it as the purposes of the law to either hamper ordinary business or hinder experiments on the part of the farmer. Whenever any goods thus offered experimentally come to be sold in considerable amount they must be licensed the same as other fertilizing materials.

The Brand. Each package shall bear, conspicuously printed, the following statements:

The number of net pounds contained in each package.

The name or trade mark under which it is sold.

The name of the manufacturer or shipper.

The place of manufacture.

The place of business of manufacturer or shipper.

The percentage of nitrogen or its equivalent in ammonia.

The percentage of potash soluble in water.

The percentage of phosphoric acid in available form.

The percentage of total phosphoric acid.

The Certificate. There shall be filed annually between Nov. 15 and Dec. 15 with the Director of the Station a certificate containing an accurate statement of the brand. This certificate applies to the next succeeding calendar year.

Analysis Fee. For each brand of fertilizer sold or offered for sale in the State there shall be paid annually "an analysis fee as follows: Ten dollars for the phosphoric acid and five dollars each for the nitrogen and potash contained or said to be contained in the fertilizer."

The License. Upon the payment of the fee and receipt of the certificate the Director of the Station "shall issue a certificate of compliance."

Penalty. Violations of the law are punishable "by a fine not exceeding one hundred dollars for the first offense and not exceeding two hundred dollars for each subsequent offense."

Executive. The Director of the Station is directed to collect and analyze samples of all fertilizers sold in the State; to publish the results of the analyses together with additional information of public benefit; and to diligently enforce the provisions of the law.

The full text of the law is printed in Official Inspections 12. A copy will be sent on request made to the Director of the Experiment Station, Orono, Maine.

Fertility and Plant Food.

To produce profitable crops and at the same time to maintain and even to increase the productive capacity of the soil may rightly be termed "good farming." Many farmers are able to do this, and the knowledge of how to do it has been largely acquired through years of experience, during which the character of the soil, its adaptability for crops, and the methods of its management and manuring have been made the subjects of careful study, without, however, any definite and accurate knowledge concerning manures and their functions in relation to soils and crops. Those who desire to study these questions, are invited to write the Dean of the College of Agriculture, University of Maine, Orono, Maine, who will gladly send a list of

suitable books and give full information relative to correspondence courses on this subject.*

Soils vary greatly in their capabilities of supplying food to crops. Different ingredients are deficient in different soils. The way to learn what materials are proper in a given case is by observation and experiment. The rational method for determining what ingredients of plant-food a soil fails to furnish in abundance, and how these lacking materials can be most economically supplied, is to put the questions to the soil with different fertilizing materials and get the reply in the crops produced. How to make these experiments is explained in Circular No. 8 of the Office of Experiment Stations of the U. S. Department of Agriculture. A copy of this circular can be had by applying to the Secretary of Agriculture, Washington, D. C.

The chief use of fertilizers is to supply plant-food. It is good farming to make the most of the natural resources of the soil and of the manures produced on the farm, and to depend upon artificial fertilizers only to furnish what more is needed. It is not good economy to pay high prices for materials which the soil may itself yield, but it is good economy to supply the lacking ones in the cheapest way. The rule in the purchase of costly commercial fertilizers should be to select those that supply, in the best forms and at the lowest cost, the plant-food which the crop needs and the soil fails to furnish.

Plants differ widely with respect to their capacities for gathering their food from soil and air; hence the proper fertilizer in a given case depends upon the crop as well as upon the soil. The fertility of the soil would remain practically unchanged if all the ingredients removed in the various farm products were restored to the land. This may be accomplished by feeding the crops grown on the farm to animals, carefully saving the manure and returning it to the soil. If it is practicable to

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* Farmers' Bulletin 44 of the U. S. Department of Agriculture discussing commercial fertilizers will be sent to any address on application to the Secretary of Agriculture, Washington, D. C. The Maine Bulletin, Vol. XI, No. 5, discusses The Restoration of Fertility and Commercial Fertilizers. This can be obtained by writing the College of Agriculture, Orono, Maine. Mr. W. H. Bowker in a pamphlet entitled "Plant Food" treats the subject from the standpoint of his long experience as student and manufacturer. A copy of this booklet can be had by writing Mr. W. H. Bowker, 43 Chatham Street, Boston, Mass.

pursue a system of stock feeding in which those products of the farm which are comparatively poor in fertilizing constituents are exchanged in the market for feeding stuffs of high fertilizing value, the loss of soil fertility may be reduced to a minimum, or there may be an actual gain in fertility.

Constituents of Fertilizers.

The only ingredients of plant-food which we ordinarily need to consider in fertilizers are potash, lime, phosphoric acid, and nitrogen. The available supply of lime is often insufficient; hence one reason for the good effect so often observed from the application of lime, and of plaster, which is a compound of lime and sulphuric acid. The remaining substances, nitrogen, phosphoric acid and potash, are the most important ingredients of our common commercial fertilizers, both because of their scarcity in the soil and their high cost. It is in supplying these that phosphates, bone manures, potash-salts, guano, nitrate of soda, and most other commercial fertilizers are chiefly useful.

The term "form" as applied to a fertilizing constituent has reference to its combination or association with other constituents which may be useful, though not necessarily so. The form of the constituent, too, has an important bearing upon its availability, and hence upon its usefulness as plant food. Many materials containing the essential elements are practically worthless as sources of plant-food because the form is not right; the plants are unable to extract them from their combinations; they are "unavailable." In many of these materials the forms may be changed by proper treatment, in which case they become valuable not because the element itself is changed, but because it then exists in such form as readily to feed the plant.

Nitrogen is the most expensive of the three essential fertilizing elements. It exists in three different forms, organic nitrogen, ammonia and nitrate.

Organic nitrogen exists in combination with other elements either as vegetable or animal matter. All materials containing organic nitrogen are valuable in proportion to their rapidity of decay, because change of form must take place before the nitrogen can serve as plant food. Organic nitrogen differs in availability not only according to the kind of material which supplies it, but according to the treatment it receives.

Nitrogen as ammonia usually exists in commercial manures in the form of sulphate of ammonia and is more readily available than organic nitrogen. While nitrogen in the form of ammonia is extremely soluble in water, it is not readily removed from the soil by leaching, as it is held by the organic compounds of the soil.

Nitrogen as nitrate exists in commercial products chiefly as nitrate of soda. Nitrogen in this form is directly and immediately available, no further changes being necessary. It is completely soluble in water, and diffuses readily throughout the soil. It differs from the ammonia compounds in forming no insoluble compounds with soil constituents and may be lost by leaching.

Phosphoric acid is derived from materials called phosphates, in which it may exist in combination with lime, iron, or alumina as phosphates of lime, iron or alumina. Phosphate of lime is the form most largely used as a source of phosphoric acid. Phosphoric acid occurs in fertilizers in three forms: That soluble in water and readily taken up by plants; that insoluble in water but still readily used by plants and known as "reverted;" and that soluble only in strong acids and consequently very slowly used by the plant. The "soluble" and "reverted" together constitute the "available" phosphoric acid. The phosphoric acid in natural or untreated phosphates is insoluble in water, and not readily available to plants. If it is combined with organic substances as in animal bone, the rate of decay is more rapid than if with purely mineral substances. The insoluble phosphates may be converted into soluble forms by treatment with strong acids. Such products are known as acid phosphates or superphosphates. The "insoluble phosphoric acid" of a high cost commercial fertilizer has little or no value to the purchaser because at the usual rate of application the quantity is too small to make any perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal amount of more needful and valuable constituents.

Potash in commercial fertilizers exists chiefly as muriates and sulphates. With potash the form does not exert so great an influence upon availability as is the case with nitrogen and phosphoric acid. All ordinary forms are freely soluble in water, and are believed to be nearly if not quite equally available as

food. The form of the potash has an important influence upon the quality of certain crops. For example, the results of experiments seem to indicate that the quality of tobacco, and certain other crops, is unfavorably influenced by the use of muriate of potash, while the same crops show a superior quality if materials free from chlorides have been used as the source of potash.

Valuation of Fertilizers.

The agricultural value of any fertilizing constituent is measured by the value of the increase of the crop produced by its use, and is, of course, a variable factor, depending upon the availability of the constituent, and the value of the crop produced. The form of the materials used must be carefully considered in the use of manures. Slow-acting materials cannot be expected to give profitable returns upon quick growing crops, nor expensive materials profitable returns when used for crops of relatively low value.

The agricultural value is distinct from what is termed "commercial value," or cost in market. This last is determined by market and trade conditions, as cost of production of the crude material, methods of manipulation required, etc. Since there is no strict relation between agricultural and commercial or market value, it may happen that an element in its most available form, and under ordinary conditions of high agricultural value, costs less in market than the same element in less available forms and of a lower agricultural value. The commercial value has reference to the material as an article of commerce, hence commercial ratings of various fertilizers have reference to their relative cost and are used largely as a means by which the different materials may be compared.

The commercial valuation of a fertilizer consists in calculating the retail trade-value or cash-cost at freight centers (in raw materials of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer. Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which $20 to $75 per ton are paid, depend for their trade value exclusively on the substances, nitrogen, phosphoric acid and potash, which are com-

paratively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce. The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the trade-value of the above-named ingredients a suitable margin for the expenses of manufacturer, etc., and for the convenience or other advantage incidental to their use.

For many years this Station has not printed an estimate of the commercial value of the different brands licensed in the State. If anyone wishes to calculate the commercial value he can do so by using the trade values adopted for 1909 by the Experiment Stations of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Rhode Island and Vermont. These valuations represent the average retail prices at which these ingredients could be purchased during the three months preceding March 1, 1909, in ton lots at tide water in the states named. On account of the greater distance from the large markets the prices for Maine at tide water would probably be somewhat higher than those quoted.

TRADE VALUES OF FERTILIZING INGREDIENTS FOR 1909.

	Cents per pound
Nitrogen in nitrates	16½
in ammonia salts	17
Organic nitrogen in dry and fine ground fish, meat and blood, and in mixed fertilizers	19
in fine bone and tankage	19
in coarse bone and tankage	14
Phosphoric acid, water-soluble	4
citrate-soluble	3½
in fine ground bone and tankage	3½
in coarse bone and tankage	3
in cotton seed meal, castor pomace and ashes	3
in mixed fertilizers, if insoluble in ammonium citrate	2
Potash as high grade sulphate and in forms free from muriate or chlorides	5
as muriate	4¼

RULES FOR CALCULATING VALUATION OF FERTILIZERS.

The commercial valuation will be accurate enough as a means of comparison if the following rule is adopted:

Multiply 3.8 by the percentage of nitrogen.
Multiply 0.7 by the percentage of available phosphoric acid.
Multiply 0.4 by the percentage of insoluble phosphoric acid.
Multiply 1.0 by the percentage of potash.

The sum of these 4 products will be the commercial valuation per ton on the basis taken.

Illustration. The table of analyses shows a certain fertilizer to have the following composition: Nitrogen 3.30 per cent; Available phosphoric acid 8.00 per cent; Insoluble phosphoric acid 1.00 per cent; Potash 6.00 per cent. The valuation in this case will be computed thus:

Nitrogen,	3.8 × 3.30,	$12 54
Available phosphoric acid,	0.7 × 8.00,	5 60
Insoluble phosphoric acid,	0.4 × 1.00,	40
Potash,	1.0 × 6.00,	6 00
		$24 54

Since this rule assumes all the nitrogen to be organic and all the potash to be in the form of the sulphate, it is evident that the valuations thus calculated must not be taken as the only guide in the choice of a fertilizer. In every case the farmer should consider the needs of his soil before he begins to consider the cost. In many instances a little careful experimenting will show him that materials containing either nitrogen, potash, or phosphoric acid alone will serve his purpose as fully as a "complete fertilizer," in which he must pay for all three constituents, whether needed or not.

Results of Inspection.

In 1908 attention was called to two matters concerning the marking of fertilizer packages which were, in the judgment of the Director of the Station, in violation of the law. Though these were not particularly serious it is gratifying to know that corrections have been made and the suggestions complied with.

There has been no reason for thinking at any time during the past 15 years that commercial fertilizers have been offered in Maine with fraudulent intent. The companies that have been doing business for many years have learned to manufacture commercial fertilizers so that they correspond for the most part quite closely to their professed analysis. A study of the analyses here reported will show that such companies as well as some of the newer companies are able to manufacture their goods so that the samples found by the Station representatives agree very closely with their professed analysis. It is perhaps not clearly understood by the user of commercial fertilizers what this means in the way of care on the part of the manufacturer.

Usually the sample by the Station representatives is taken at the warehouse from 8 to 10 packages. The samples thus taken are carefully mixed and a pint jar filled from the mixture. When the jar is received at the laboratory the goods are again sampled. The amount which is actually used by the chemist is only a small fraction of an ounce. Thus it happens that the very small amount analyzed by the chemist represents many tons. That there is substantial agreement is high testimony not only to the honesty of the fertilizer manufacturer but to the care with which his goods are manufactured.

The increase of home mixing in the State has brought it about that there are some people now engaged in making fertilizers for commercial purposes who are not as efficiently equipped either in their knowledge of the business or in their facilities as are the older manufacturers. It is perfectly possible to accurately compound fertilizers with a minimum of machinery so that the goods will be evenly mixed and in good mechanical condition. In order to do this, however, the person manufacturing the goods must understand what he is about and know accurately the analysis of the materials that are entering into the makeup.

While on the whole the analyses here reported are exceedingly satisfactory there are a few instances in the case of goods that are apparently dry mixed that are quite otherwise. These cases are being investigated under the law and it does not seem proper to discuss them at any length or the brands and makers by name until after they have been given the fullest opportunity to present evidence that they may have. Reports have

come to us of bad mechanical condition, largely on the part of one manufacturer, and at present there seems to be justification for this complaint. Another manufacturer whose goods appear in the State for the first time has apparently signally failed in making good his claims. There is reason to believe that this was unintentional and due to the mistakes or incompetency on the part of the person employed to manufacture the goods.

The user of fertilizers should carefully study the results of the analyses given in this bulletin. The failure of a single sample to conform to its analysis may be no serious fault of the manufacturer as it may happen that for some reason the sample which was examined by the Station did not fairly represent the goods. While only experienced men draw the Station samples, long experience has taught us that even exercising the greatest care possible there may be mistakes on our part as well as on the part of the manufacturer. If many of the different brands made by the company whose fertilizer a man has been using do not conform within reasonable limits to their guaranteed analysis he should carefully consider the advisability of getting goods from other manufacturers.

In the tables that follow, the analyses of the samples of commercial fertilizers collected in the open market in the spring of 1909 by the Station representatives are given. The samples were drawn by experienced men and every precaution was taken to make sure that they fairly represented the goods sampled. So far as possible the samples were taken in the large warehouses where a large amount of the goods were stored as received from the factory. They were taken in almost every instance from at least 10 packages and where possible in the presence of a representative of the manufacturers.

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
	AMERICAN AGRICULTURAL CHEMICAL CO., NEW YORK, N. Y.
1459	A. A. Potato Grower
1072	A. A. C. Co.'s Aroostook Complete Manure
1405	A. A. C. Co.'s Aroostook Complete Manure
1020	A. A. C. Co.'s Aroostook High Grade
1263	A. A. C. Co.'s Aroostook High Grade
1022	A. A. C. Co.'s Complete Manure with 10% Potash
1339	A. A. C. Co.'s Complete Manure with 10% Potash
1140	A. A. C. Co.'s Grass & Oats Fertilizer
1221	A. A. C. Co.'s Grass & Oats Fertilizer
1039	A. A. C. Co.'s High Grade Fertilizer with 10% Potash
1182	A. A. C. Co.'s High Grade Fertilizer with 10% Potash
1340	A. A. C. Co.'s Northern Maine Potato Special
1394	A. A. C. Co.'s Northern Maine Potato Special
1095	A. A. C. Co.'s Peerless Potato Manure
1144	A. A. C. Co.'s Peerless Potato Manure
1174	Bradley's Alkaline Bone with Potash
1261	Bradley's Alkaline Bone with Potash
1079	Bradley's Complete Manure for Potatoes & Vegetables
1169	Bradley's Complete Manure for Potatoes & Vegetables
1006	Bradley's Complete Manure with 10% Potash
1404	Bradley's Complete Manure with 10% Potash
1096	Bradley's Corn Phosphate
1181	Bradley's Corn Phosphate
1100	Bradley's Eureka Fertilizer
1231	Bradley's Eureka Fertilizer
1080	Bradley's Niagara Phosphate
1228	Bradley's Niagara Phosphate
1076	Bradley's Potato Fertilizer
1170	Bradley's Potato Fertilizer
1172	Bradley's Potato Manure
1232	Bradley's Potato Manure
1078	Bradley's XL Superphosphate of Lime
1183	Bradley's XL Superphosphate of Lime
1011	Clark's Cove Bay State Fertilizer
1256	Clark's Cove Bay State Fertilizer, for Seeding Down
1010	Clark's Cove Bay State Fertilizer G. G.
1254	Clark's Cove Bay State Fertilizer G. G.
1460	Clark's Cove Defiance Complete Manure
1029	Clark's Cove Great Planet Manure AA
1379	Clark's Cove Great Planet Manure AA
1033	Clark's Cove King Phillip Alkaline Guano for All Crops
1252	Clark's Cove King Phillip Alkaline Guano for All Crops
1004	Clark's Cove Potato Fertilizer
1255	Clark's Cove Potato Fertilizer
1061	Clark's Cove Potato Manure
1249	Clark's Cove Potato Manure
1016	Cleveland Fertilizer for All Crops
1014	Cleveland High Grade Complete Manure
1035	Cleveland Potato Phosphate
1246	Cleveland Potato Phosphate

Analysis of Station Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
			Total.					Available.		Total.			
	As Ammonia.	As Nitrates.	Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
1459	0.17	1.07	3.28	3.70	4.34	2.96	2.91	7.30	7.00	10.21	9.00	9.03	10.00
1072	0.12	0.90	2.68	2.47	2.60	4.22	2.19	6.82	6.00	9.01	......	10.27	10.00
1405	0.87	......	2.27	2.47	4.96	1.70	1.28	6.66	6.00	7.94	......	9.06	10.00
1020	0.12	0.40	4.18	4.12	5.39	1.61	2.40	7.00	7.00	9.40	......	6.86	7.00
1263	0.09	0.69	4.08	4.12	4.90	2.18	2.74	7.08	7.00	9.82	......	7.19	7.00
1022	0.08	1.49	3.45	3.30	4.49	1.91	1.47	6.40	6.00	7.87	7.00	9.34	10.00
1339	0.94	......	3.22	3.30	5.55	1.74	1.37	7.29	6.00	8.66	7.00	9.65	10.00
1140	......	......	......	......	7.69	3.45	2.32	11.14	11.00	13.46	......	2.21	2.00
1221	......	......	......	......	7.53	3.61	2.23	11.14	11.00	13.37	......	2.10	2.00
1039	0.07	1.22	3.02	2.40	2.79	4.44	2.92	7.23	6.00	10.15	7.00	10.15	10.00
1182	0.19	0.19	2.56	2.40	3.60	3.41	2.00	7.01	6.00	9.01	7.00	9.63	10.00
1340	0.10	0.77	3.82	3.70	3.86	3.45	2.90	7.31	7.00	10.21	......	10.11	10.00
1394	0.15	1.77	3.96	3.70	4.91	2.69	1.81	7.60	7.00	9.41	......	9.80	10.00
1095	0.08	1.16	3.32	3.29	6.12	2.40	2.51	8.52	8.00	11.03	......	7.29	7.00
1144	0.14	0.62	3.46	3.29	3.43	5.10	2.86	8.53	8.00	11.39	......	6.70	7.00
1174	......	......	......	......	8.21	3.17	2.23	11.38	11.00	13.61	12.00	1.94	2.00
1261	......	......	......	......	7.45	3.19	2.42	10.64	11.00	13.06	12.00	2.33	2.00
1079	0.08	1.06	3.50	3.30	6.46	2.02	2.52	8.48	8.00	11.00	9.00	6.60	7.00
1169	0.10	0.25	3.34	3.30	5.90	2.85	2.30	8.75	8.00	11.05	9.00	6.75	7.00
1006	0.09	0.28	3.08	3.30	4.22	2.66	1.31	6.88	6.00	8.19	7.00	10.06	10.00
1404	0.16	0.19	3.26	3.30	3.59	2.92	1.53	6.51	6.00	8.04	7.00	10.19	10.00
1096	0.14	0.18	2.30	2.06	5.63	2.50	2.60	8.13	8.00	10.73	10.00	1.93	1.50
1181	0.15	0.71	2.48	2.06	5.61	2.62	2.58	8.23	8.00	10.81	10.00	1.78	1.50
1100	0.20	......	1.20	1.03	4.43	4.29	2.61	8.72	8.00	11.33	10.00	2.25	2.00
1231	0.29	......	1.10	1.03	3.43	4.93	2.55	8.36	8.00	10.91	10.00	2.00	2.00
1080	0.27	......	1.24	0.82	2.81	4.19	2.77	7.00	7.00	9.77	8.00	1.28	1.00
1228	0.21	......	0.90	0.82	3.11	4.25	2.45	7.36	7.00	9.81	8.00	1.22	1.00
1076	0.15	0.11	2.32	2.06	5.58	2.61	2.97	8.19	8.00	11.16	10.00	3.33	3.00
1170	0.10	0.36	2.44	2.06	6.25	2.84	2.54	9.09	8.00	11.63	10.00	3.26	3.00
1172	0.20	0.07	2.86	2.50	2.58	5.90	3.16	8.48	6.00	11.64	8.00	5.50	5.00
1232	0.24	......	1.80	2.50	2.42	3.68	2.59	6.10	6.00	8.69	8.00	4.86	5.00
1078	0.15	0.80	2.74	2.50	7.12	2.55	3.07	9.67	9.00	12.74	11.00	2.36	2.00
1183	0.22	0.65	2.82	2.50	6.94	4.10	1.82	11.04	9.00	12.86	11.00	2.39	2.00
1011	0.24	0.79	2.62	2.50	6.81	2.91	2.80	9.72	9.00	12.52	11.00	2.31	2.00
1256	0.30	......	1.22	1.03	3.35	5.35	2.78	8.70	8.00	11.48	10.00	1.88	2.00
1010	0.24	......	2.10	2.06	5.53	2.33	2.84	7.86	8.00	10.70	10.00	1.82	1.50
1254	0.12	0.58	2.12	2.06	4.95	3.21	3.00	8.16	8.00	11.16	10.00	1.90	1.50
1460	0.23	......	1.31	0.82	3.46	3.97	2.78	7.43	7.00	10.21	8.00	1.69	1.00
1029	0.22	0.91	3.37	3.30	5.50	2.63	2.60	8.13	8.00	10.73	9.00	7.42	7.00
1379	0.70	......	3.08	3.30	5.79	3.65	0.64	9.44	8.00	10.08	9.00	6.71	7.00
1033	0.18	......	1.26	1.03	4.96	3.20	2.80	8.16	8.00	10.96	10.00	2.08	2.00
1252	0.30	......	1.08	1.03	3.54	4.66	2.77	8.20	8.00	10.97	10.00	1.89	2.00
1004	0.26	0.44	2.40	2.06	6.07	2.15	2.78	8.22	8.00	11.00	10.00	3.44	3.00
1255	0.16	......	2.08	2.06	4.99	3.01	3.64	8.00	8.00	11.61	10.00	3.28	3.00
1061	0.22	0.74	2.40	2.50	2.68	4.49	3.24	7.17	6.00	10.41	8.00	5.87	5.00
1249	0.24	......	2.62	2.50	2.07	4.31	2.36	6.41	6.00	8.77	8.00	4.72	5.00
1016	0.17	......	1.33	1.03	4.54	3.94	2.68	8.48	8.00	11.16	10.00	2.35	2.00
1014	0.16	0.80	3.40	3.30	5.99	2.61	2.64	8.60	8.00	11.24	9.00	6.83	7.00
1035	0.20	0.53	2.36	2.06	6.07	2.61	2.69	8.68	8.00	11.37	10.00	3.24	3.00
1246	0.22	0.56	2.18	2.06	5.36	3.78	2.77	9.14	8.00	11.91	10.00	3.08	3.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
1245	Cleveland Super-phosphate
1089	Crocker's Ammoniated Corn Phosphate
1141	Crocker's Ammoniated Corn Phosphate
1110	Crocker's Aroostook Potato Special
1171	Crocker's Aroostook Potato Special
1109	Crocker's New Rival Ammoniated Super-phosphate
1175	Crocker's New Rival Ammoniated Super-phosphate
1074	Crocker's Potato, Hop & Tobacco Phosphate
1265	Crocker's Potato, Hop & Tobacco Phosphate
1111	Crocker's Special Potato Manure
1219	Crocker's Special Potato Manure
1092	Cumberland Potato Fertilizer
1236	Cumberland Potato Fertilizer
1086	Cumberland Super-phosphate
1233	Cumberland Super-phosphate
1070	Darling's Blood, Bone & Potash
1403	Darling's Blood, Bone & Potash
1094	Great Eastern General Fertilizer
1222	Great Eastern General Fertilizer
1107	Great Eastern High Grade Potato Manure
1388	Great Eastern High Grade Potato Manure
1406	Great Eastern High Grade Potato Manure
1071	Great Eastern Northern Corn Special
1142	Great Eastern Northern Corn Special
1069	Great Eastern Potato Manure
1201	Great Eastern Potato Manure
1097	Lazaretto Aroostook Potato Guano
1463	Lazaretto Corn Guano
1073	Lazaretto High Grade Potato Guano
1352	Lazaretto High Grade Potato Guano
1075	Lazaretto Propeller Potato Guano
1454	Otis' Potato Fertilizer
1455	Otis' Super-phosphate
1053	Pacific Bone & Potash
1147	Pacific Bone & Potash
1012	Pacific Grass & Grain Fertilizer
1146	Pacific Grass & Grain Fertilizer
1021	Pacific High Grade General Fertilizer
1153	Pacific Nobsque Guano for All Crops
1062	Pacific Potato Special
1247	Pacific Potato Special
1093	Packer's Union Animal Corn Fertilizer
1200	Packer's Union Animal Corn Fertilizer
1341	Packer's Union Gardner's Complete Manure
1112	Packer's Union Potato Manure
1203	Packer's Union Potato Manure
1220	Packer's Union Potato Manure
1066	Packer's Union Universal Fertilizer
1202	Packer's Union Universal Fertilizer
1126	Quinnipiac Corn Manure
1253	Quinnipiac Corn Manure

Analysis of Station Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Ammonia.	As Nitrates.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
1245	0.17	0.15	2.06	2.06	4.83	3.42	2.87	8.25	8.00	11.12	10.00	1.77	1.50
1089	0.12	......	2.06	2.06	5.61	2.83	2.49	8.44	8.00	10.93	......	1.80	1.50
1141	0.07	0.09	2.02	2.06	4.72	3.12	2.93	7.84	8.00	10.77	......	1.86	1.50
1110	0.09	0.87	2.64	2.06	6.06	3.66	2.55	9.72	8.00	12.27	......	6.88	6.00
1171	0.23	......	2.36	2.06	3.78	4.79	2.93	8.57	8.00	11.50	......	6.27	6.00
1109	0.13	......	1.44	1.03	5.91	2.71	3.11	8.62	8.00	11.73	......	2.03	2.00
1175	0.26	......	1.18	1.03	3.72	4.67	2.70	8.39	8.00	11.09	......	2.19	2.00
1074	0.13	......	2.56	2.06	5.59	2.53	2.97	8.12	8.00	11.09	......	3.35	3.00
1265	0.15	0.63	2.10	2.06	6.56	2.32	2.49	8.88	8.00	11.37	......	3.23	3.00
1111	0.07	1.29	3.18	3.29	4.35	2.71	1.26	7.06	6.00	8.32	......	10.47	10.00
1219	0.13	0.56	2.94	3.29	4.32	2.33	2.25	6.65	6.00	8.90	......	9.98	10.00
1092	0.16	0.54	2.36	2.06	5.99	2.27	2.87	8.26	8.00	11.13	10.00	3.24	3.00
1236	0.15	0.08	2.32	2.06	5.45	2.28	3.87	7.73	8.00	11.60	10.00	3.29	3.00
1086	0.10	......	2.12	2.06	6.14	2.46	2.24	8.60	8.00	10.84	10.00	1.67	1.50
1233	0.14	0.60	2.08	2.06	4.74	2.97	3.02	7.71	8.00	10.73	10.00	1.79	1.50
1070	0.15	0.69	4.34	4.10	5.53	2.25	2.55	7.78	7.00	10.33	8.00	7.08	7.00
1403	0.15	1.92	3.99	4.10	3.75	5.21	0.61	8.96	7.00	9.57	8.00	7.51	7.00
1094	0.15	......	1.38	0.82	6.01	2.52	2.69	8.53	8.00	11.22	......	4.01	4.00
1222	0.21	......	1.04	0.82	4.63	3.60	2.55	8.23	8.00	10.78	......	4.15	4.00
1107	0.07	1.34	3.26	3.29	4.45	2.46	1.28	6.91	6.00	8.19	......	10.18	10.00
1388	0.17	1.43	2.98	3.29	3.41	2.30	1.80	5.71	6.00	7.51	......	9.79	10.00
1406	0.22	0.38	3.20	3.29	3.08	3.46	1.51	6.54	6.00	8.05	......	10.41	10.00
1071	0.12	......	2.28	2.06	5.61	2.81	2.36	8.42	8.00	10.78	......	1.85	1.50
1142	0.09	0.97	2.04	2.06	5.12	3.12	3.05	8.24	8.00	11.29	......	1.95	1.50
1069	0.15	0.61	2.38	2.06	5.58	2.49	2.98	8.07	8.00	11.05	......	3.19	3.00
1201	0.27	......	2.22	2.06	5.02	2.84	3.96	7.86	8.00	11.82	......	3.23	3.00
1097	0.14	......	1.08	0.82	6.04	2.87	2.61	8.91	8.00	11.52	......	4.11	4.00
1463	0.14	0.53	2.26	1.64	5.30	2.98	2.96	8.28	8.00	11.24	......	3.26	2.00
1073	0.07	1.37	3.52	3.29	4.43	2.17	1.19	6.60	6.00	7.79	......	9.91	10.00
1352	0.15	1.33	3.30	3.29	5.17	1.88	1.28	7.05	6.00	8.33	......	10.19	10.00
1075	0.12	0.24	2.82	2.06	5.32	3.05	2.37	8.37	8.00	10.74	......	7.11	6.00
1454	0.13	0.28	2.31	2.06	6.76	2.51	2.76	9.27	8.00	12.03	10.00	3.24	3.00
1455	0.17	......	2.45	2.06	6.62	2.28	2.55	8.90	8.00	11.45	10.00	1.97	1.50
1053	......	......	......	......	8.18	3.16	2.51	11.34	10.00	13.85	11.00	1.73	2.00
1147	......	......	......	......	8.29	2.93	2.11	11.22	10.00	13.33	11.00	2.09	2.00
1012	0.26	......	1.20	0.82	3.04	5.11	2.19	8.15	7.00	10.34	8.00	1.27	1.00
1146	0.18	......	1.36	0.82	3.29	5.35	2.09	8.64	7.00	10.73	8.00	1.44	1.00
1021	0.09	1.37	3.58	3.30	5.64	2.44	2.96	8.08	8.00	11.04	9.00	7.31	7.00
1153	0.32	......	1.24	1.03	3.91	4.42	2.72	8.33	8.00	11.05	10.00	2.28	2.00
1062	0.18	0.54	2.82	2.06	5.83	2.75	2.86	8.58	8.00	11.44	10.00	3.28	3.00
1247	0.14	0.12	2.12	2.06	5.10	2.90	3.78	8.00	8.00	11.78	10.00	2.95	3.00
1093	0.12	0.09	2.88	2.06	7.00	2.04	2.08	9.04	8.00	11.12	......	2.34	2.00
1200	0.19	0.39	2.82	2.06	7.35	2.56	2.55	9.91	8.00	12.46	......	2.27	2.00
1341	1.04	......	2.30	2.47	3.30	3.37	3.44	6.67	6.00	10.11	......	10.50	10.00
1112	0.20	0.60	2.32	2.06	5.77	2.57	2.56	8.34	8.00	10.90	......	6.76	6.00
1203	0.28	0.59	2.06	2.06	3.67	4.65	2.91	8.32	8.00	11.23	......	5.88	6.00
1220	0.26	0.54	2.04	2.06	3.19	5.04	2.78	8.23	8.00	11.01	......	6.03	6.00
1066	0.16	0.12	1.34	0.82	6.63	2.54	2.11	9.17	8.00	11.28	......	3.74	1.00
1202	0.21	......	1.10	0.82	4.47	4.03	2.36	8.50	8.00	10.86	......	4.53	4.00
1126	0.14	......	2.16	2.06	6.25	3.12	1.49	9.37	8.00	10.86	10.00	1.83	1.50
1253	0.12	0.30	2.06	2.06	4.85	3.18	3.28	8.03	8.00	11.31	10.00	1.68	1.50

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
1127	Quinnipiac Market Garden Manure
1387	Quinnipiac Market Garden Manure
1243	Quinnipiac Potato Manure
1199	Quinnipiac Potato Phosphate
1248	Quinnipiac Potato Phosphate
1037	Read's Farmers' Friend Super-phosphate
1258	Read's Farmers' Friend Super-phosphate
1028	Read's High Grade Farmers' Friend Super-phosphate
1155	Read's High Grade Farmers' Friend Super-phosphate
1036	Read's Potato Manure
1150	Read's Potato Manure
1025	Read's Practical Potato Special Fertilizer
1154	Read's Practical Potato Special Fertilizer
1156	Read's Standard Superphosphate
1260	Read's Standard Superphosphate
1032	Read's Sure Catch Fertilizer
1259	Read's Sure Catch Fertilizer
1018	Read's Vegetable & Vine Fertilizer
1151	Read's Vegetable & Vine Fertilizer
1149	Soluble Pacific Guano
1250	Soluble Pacific Guano
1030	Standard A Brand
1242	Standard A Brand
1031	Standard Bone & Potash
1239	Standard Bone & Potash
1148	Standard Complete Manure
1338	Standard Complete Manure
1046	Standard Fertilizer
1158	Standard Fertilizer
1023	Standard Guano for All Crops
1235	Standard Guano for All Crops
1159	Standard Special for Potatoes
1262	Standard Special for Potatoes
1237	Williams & Clark Americus Ammoniated Bone Super-phosphate
1241	Williams & Clark Americus Corn Phosphate
1238	Williams & Clark Americus High Grade Special
1240	Williams & Clark Americus Potato Manure
1234	Williams & Clark Royal Bone Phosphate for All Crops
	ARMOUR FERTILIZER WORKS, BALTIMORE, MD.
1433	All Soluble
1347	Bone, Blood and Potash
1434	Bone, Blood and Potash
1299	Complete Potato Fertilizer
1348	Complete Potato Fertilizer
1301	Fruit & Root Crop Special
1302	Grain Grower
1349	Grain Grower
1432	High Grade Potato
1300	Wheat, Corn & Oat Special

Analysis of Station Samples, 1909.

Station number.	Nitrogen. As Ammonia.	Nitrogen. As Nitrates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1127	0.09	1.51	3.36	3.30	6.32	1.88	2.07	8.20	8.00	10.27	9.00	6.89	7.00
1387	0.10	0.72	3.02	3.30	4.72	3.93	2.96	8.65	8.00	11.61	9.00	7.50	7.00
1243	0.24	1.02	3.00	2.50	2.36	4.00	2.64	6.36	6.00	9.00	8.00	4.86	5.00
1199	0.13	.....	2.14	2.06	5.90	2.59	2.55	8.49	8.00	11.04	10.00	3.45	3.00
1248	0.15	0.37	2.04	2.06	5.18	2.97	3.76	8.15	8.00	11.91	10.00	3.15	3.00
1037	0.18	0.56	2.44	2.06	6.18	2.89	2.66	9.07	8.00	11.73	10.00	3.25	3.00
1258	0.35	0.11	2.20	2.06	4.63	3.48	3.74	8.11	8.00	11.85	10.00	3.19	3.00
1028	0.08	1.18	3.38	3.30	4.53	2.75	1.25	7.28	6.00	8.53	7.00	9.91	10.00
1155	0.08	1.43	3.60	3.30	4.85	1.82	1.66	6.67	6.00	8.33	7.00	9.26	10.00
1036	0.07	1.18	2.70	2.40	2.81	4.27	3.06	7.08	6.00	10.14	7.00	9.69	10.00
1150	0.22	0.10	2.68	2.40	3.17	4.17	2.64	7.34	6.00	9.98	7.00	9.79	10.00
1025	0.21	......	1.38	0.82	4.32	3.79	1.96	8.11	4.00	10.07	5.00	9.15	8.00
1154	0.24	......	1.56	0.82	4.29	3.32	2.25	7.61	4.00	9.86	5.00	7.30	8.00
1156	0.20	0.15	1.40	0.82	4.77	3.56	2.36	8.33	8.00	10.69	10.00	4.53	4.00
1260	0.19	.....	1.10	0.82	4.45	3.16	2.71	7.61	8.00	10.32	10.00	5.58	4.00
1032	......	......	......	......	7.40	3.17	2.82	10.57	10.00	13.39	11.00	1.91	2.00
1259	......	......	......	......	7.50	3.07	2.62	10.57	10.00	13.19	11.00	2.27	2.00
1018	0.23	......	2.23	2.06	4.65	2.02	0.75	6.67	8.00	7.42	10.00	9.12	6.00
1151	0.19	......	2.28	2.06	2.44	4.68	3.60	7.12	8.00	10.72	10.00	6.00	6.00
1149	0.18	0.69	2.48	2.06	5.25	2.90	2.44	8.15	8.00	10.59	10.00	1.81	1.50
1250	0.15	0.63	2.14	2.06	5.02	3.15	3.25	8.17	8.00	11.42	10.00	1.78	1.50
1030	0.09	......	1.18	0.82	3.46	4.10	3.07	7.56	7.00	10.63	8.00	1.48	1.00
1242	0.30	......	0.94	0.82	2.89	4.55	2.64	7.44	7.00	10.08	8.00	1.46	1.00
1031	......	......	......	......	7.35	3.34	3.42	10.69	10.00	14.11	11.00	1.79	2.00
1239	......	......	......	......	7.73	3.03	2.30	10.79	10.00	13.09	11.00	2.11	2.00
1148	0.09	1.33	3.38	3.30	6.48	2.13	1.95	8.61	8.00	10.56	9.00	6.85	7.00
1338	0.42	0.06	3.16	3.30	6.49	2.06	1.47	8.55	8.00	10.02	9.00	7.11	7.00
1046	0.14	0.08	2.23	2.06	5.77	2.26	2.65	8.03	8.00	10.68	10.00	1.69	1.50
1158	0.18	0.48	2.50	2.06	5.31	3.03	2.31	8.34	8.00	10.65	10.00	1.85	1.50
1023	0.19	......	1.22	1.03	4.51	3.98	2.64	8.49	8.00	11.13	10.00	1.98	2.00
1235	0.29	......	1.30	1.03	3.70	4.63	2.76	8.33	8.00	11.09	10.00	2.03	2.00
1159	0.10	0.08	2.40	2.06	6.05	2.80	2.36	8.85	8.00	11.21	10.00	3.32	3.00
1262	0.16	0.34	2.10	2.06	4.94	2.80	3.88	7.74	8.00	11.62	10.00	3.25	3.00
1237	0.14	1.00	2.98	2.50	6.73	2.74	2.97	9.47	9.00	12.44	11.00	2.25	2.00
1241	0.10	0.32	2.18	2.06	5.15	3.29	2.95	8.44	8.00	11.39	10.00	1.72	1.50
1238	0.11	0.69	3.28	3.30	6.40	2.11	1.59	8.51	8.00	10.10	9.00	6.67	7.00
1240	0.15	0.37	2.38	2.06	5.18	2.98	3.83	8.16	8.00	11.99	10.00	3.01	3.00
1234	0.31	......	1.10	1.03	3.15	4.77	2.91	8.22	8.00	11.13	10.00	2.01	2.00
1433	0.19	0.19	2.53	2.88	5.71	2.00	1.75	7.71	8.00	9.46	9.00	1.26	1.00
1347	0.38	1.03	4.14	4.11	6.79	1.83	0.71	8.62	8.00	9.36	9.00	6.83	7.00
1434	1.00	1.44	3.52	4.11	5.74	1.88	0.84	7.62	8.00	8.46	9.00	7.97	7.00
1299	0.73	0.73	3.08	3.29	5.61	1.07	0.80	6.68	6.00	7.48	7.00	9.63	10.00
1348	0.74	0.18	3.22	3.29	5.65	0.97	0.64	6.62	6.00	7.26	7.00	9.61	10.00
1301	0.12	0.38	1.64	1.65	6.70	1.52	1.38	8.22	8.00	9.60	9.00	5.06	5.00
1302	0.05	......	1.39	1.65	6.22	2.15	1.68	8.37	8.00	10.05	9.00	2.08	2.00
1349	0.07	.....	1.94	1.65	6.19	2.04	1.63	8.23	8.00	9.86	9.00	2.31	2.00
1432	0.88	......	1.70	1.65	4.61	3.53	0.55	8.11	8.00	8.69	9.00	9.71	10.00
1300	0.01	......	0.82	0.82	5.17	1.91	1.21	7.08	7.00	8.29	8.00	1.21	1.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
	BOWKER FERTILIZER CO., BOSTON, MASS.
1345	Bowker's Bone, Blood and Potash
1401	Bowker's Bone, Blood and Potash
1001	Bowker's Bone & Potash, Square Brand
1276	Bowker's Bone & Potash, Square Brand
1343	Bowker's Complete Manure for Potatoes and Vegetables
1400	Bowker's Complete Manure for Potatoes and Vegetables
1189	Bowker's Corn Phosphate
1277	Bowker's Corn Phosphate
1087	Bowker's Early Potato Manure
1344	Bowker's Early Potato Manure
1185	Bowker's Farm and Garden Phosphate
1278	Bowker's Farm and Garden Phosphate
1275	Bowker's Fresh Ground Bone
1191	Bowker's Hill & Drill Phosphate
1279	Bowker's Hill & Drill Phosphate
1007	Bowker's Market Garden Fertilizer
1286	Bowker's Market Garden Fertilizer
1186	Bowker's Potash Bone
1282	Bowker's Potash Bone
1045	Bowker's Potash or Staple Phosphate
1192	Bowker's Potato and Vegetable Fertilizer
1280	Bowker's Potato and Vegetable Fertilizer
1085	Bowker's Potato and Vegetable Phosphate
1190	Bowker's Potato and Vegetable Phosphate
1196	Bowker's Superphosphate with Potash
1281	Bowker's Superphosphate with Potash
1042	Bowker's Sure Crop Phosphate
1187	Bowker's Sure Crop Phosphate
1465	Bowker's Sure Crop Phosphate
1273	Stockbridge's Manure A for Potatoes, etc.
1408	Stockbridge's Manure A for Potatoes, etc.
1084	Stockbridge's Special Complete Manure for Corn and all Grain Crops, etc.
1270	Stockbridge's Special Complete Manure for Corn and all Grain Crops, etc.
1064	Stockbridge's Special Complete Manure for Potatoes & Vegetables, etc.
1197	Stockbridge's Special Complete Manure for Potatoes & Vegetables, etc.
1083	Stockbridge's Special Complete Manure for Quick Growth and for Forcing
1198	Stockbridge's Special Complete Manure for Quick Growth and for Forcing
1082	Stockbridge's Special Complete Manure for Seeding Down, Permanent Dressing & Legumes
1195	Stockbridge's Special Complete Manure for Seeding Down, Permanent Dressing & Legumes

Analysis of Station Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Ammonia.	As Nitrates.	Total.		Soluble.	Reverted.	Insoluble.	Available.		Total.		Found.	Guaranteed.
			Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
1345	0.12	1.82	4.22	4.11	4.13	3.64	1.34	7.77	7.00	9.11	9.00	7.26	7.00
1401	0.26	1.68	4.06	4.11	4.78	3.11	1.31	7.89	7.00	9.20	9.00	7.48	7.00
1001	0.20	......	1.86	1.65	1.50	4.98	5.32	6.48	6.00	11.80	7.00	2.15	2.00
1276	0.20	0.22	1.76	1.65	5.31	3.19	2.55	8.50	6.00	11.05	7.00	2.11	2.00
1343	0.23	1.50	3.42	3.29	4.47	2.46	1.70	6.93	6.00	8.63	7.00	9.61	10.00
1400	0.20	1.27	3.16	3.29	2.74	4.01	1.81	6.75	6.00	8.56	7.00	10.38	10.00
1189	0.16	......	1.98	1.65	4.37	3.48	4.06	7.85	8.00	11.91	9.00	2.20	2.00
1277	0.20	......	1.44	1.65	5.50	2.53	2.30	8.03	8.00	10.33	9.00	2.17	2.00
1087	0.09	1.33	3.78	3.29	6.38	1.67	2.60	8.05	8.00	10.65	9.00	6.83	7.00
1344	0.66	0.12	3.70	3.29	5.39	3.23	1.79	8.62	8.50	10.41	9.00	7.72	7.00
1185	0.14	0.05	2.34	1.65	4.42	3.72	4.06	8.14	8.00	12.20	9.00	2.21	2.00
1278	0.33	0.07	1.80	1.65	3.54	4.50	3.00	8.04	8.00	11.04	9.00	2.20	2.00
1275	0.10	......	3.14	2.47	......	......	......	......	......	19.84	22.80	......	......
1191	0.17	0.05	2.82	2.47	7.00	2.85	2.30	9.85	9.00	12.15	10.00	2.34	2.00
1279	0.90	0.28	2.58	2.47	7.61	2.75	2.58	10.36	9.00	12.94	10.00	2.10	2.00
1007	0.12	1.30	3.18	2.47	5.48	3.03	1.29	8.51	6.00	9.80	7.00	10.01	10.00
1286	0.20	0.49	2.62	2.47	3.91	2.78	1.08	6.69	6.00	7.77	7.00	10.82	10.00
1186	0.40	......	1.26	0.82	3.84	4.35	2.90	8.19	6.00	11.09	8.00	2.14	2.00
1282	0.11	......	1.02	0.82	6.17	2.36	2.51	8.53	6.00	11.04	8.00	2.28	2.00
1045	0.25	......	1.24	0.82	3.97	4.22	2.98	8.19	8.00	11.17	9.00	3.20	3.00
1192	0.20	0.26	2.82	2.47	7.48	2.72	2.02	10.20	8.00	12.22	9.00	3.93	4.00
1280	0.75	0.09	2.54	2.47	7.42	1.26	3.44	8.68	8.00	12.12	9.00	4.33	4.00
1085	0.16	0.30	2.18	1.65	5.82	2.50	3.25	8.32	8.00	11.57	9.00	2.34	2.00
1190	0.13	0.07	1.98	1.65	4.43	3.75	4.02	8.18	8.00	12.20	9.00	2.37	2.00
1196	......	......	......	......	8.41	3.17	1.63	11.58	10.00	13.21	11.00	2.24	2.00
1281	......	......	......	......	6.67	4.01	2.40	10.68	10.00	13.08	11.00	2.23	2.00
1042	0.25	......	1.26	0.82	3.95	4.56	2.89	8.51	8.00	11.40	9.00	2.42	2.00
1187	0.36	......	1.22	0.82	3.67	5.18	2.19	8.85	8.00	11.04	9.00	2.35	2.00
1465	0.38	......	1.22	0.82	3.94	4.09	3.06	8.03	8.00	11.09	9.00	2.26	2.00
1273	0.26	1.01	4.22	4.11	3.96	4.20	1.81	8.16	7.00	9.97	8.00	8.98	10.00
1408	0.19	1.15	4.10	4.11	3.25	3.94	1.15	7.19	7.00	8.34	8.00	10.77	10.00
1084	0.11	0.75	3.60	3.29	4.49	5.43	3.16	9.92	10.00	13.08	11.00	6.13	7.00
1270	0.14	0.82	3.26	3.29	3.43	6.01	2.95	9.44	10.00	12.39	11.00	6.46	7.00
1064	0.08	1.33	3.46	3.29	4.45	2.42	1.35	6.87	6.00	8.22	7.00	10.07	10.00
1197	0.08	1.52	3.28	3.29	4.39	2.47	1.75	6.86	6.00	8.61	7.00	9.36	10.00
1083	0.18	0.64	5.54	4.93	5.07	1.76	2.18	6.83	4.00	9.01	6.00	6.10	6.00
1198	0.13	0.18	5.30	4.93	4.26	2.55	2.30	6.81	4.00	9.11	6.00	6.97	6.00
1082	0.07	0.33	3.28	2.47	5.66	1.68	2.32	7.34	6.00	9.66	9.00	11.79	10.00
1195	0.25	0.74	2.28	2.47	3.11	4.38	2.45	7.49	6.00	9.94	9.00	10.06	10.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
	BUFFALO FERTILIZER CO., BUFFALO, N. Y.
1353	Buffalo "Four-Six-Ten"
1417	Buffalo "Four-Six-Ten"
1407	Buffalo "5 8 7"
1418	Buffalo "5 8 7"
	COE-MORTIMER CO., NEW YORK CITY, N. Y.
1058	E. Frank Coe's Celebrated Special Potato Fertilizer
1168	E. Frank Coe's Celebrated Special Potato Fertilizer
1291	E. Frank Coe's Celebrated Special Potato Fertilizer
1054	E. Frank Coe's Columbian Corn & Potato Fertilizer
1164	E. Frank Coe's Columbian Corn & Potato Fertilizer
1177	E. Frank Coe's Columbian Potato Fertilizer
1287	E. Frank Coe's Columbian Potato Fertilizer
1194	E. Frank Coe's Double Strength Potato Manure
1292	E. Frank Coe's Double Strength Potato Manure
1017	E. Frank Coe's Excelsior Potato Fertilizer
1288	E. Frank Coe's Excelsior Potato Fertilizer
1051	E. Frank Coe's Famous Prize Brand Grain & Grass Fertilizer
1165	E. Frank Coe's Famous Prize Brand Grain & Grass Fertilizer
1065	E. Frank Coe's Grass & Grain Special
1178	E. Frank Coe's Grass & Grain Special
1008	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1290	E. Frank Coe's High Grade Ammoniated Bone Superphosphate
1060	E. Frank Coe's High Grade Potato Fertilizer
1161	E. Frank Coe's High Grade Potato Fertilizer
1052	E. Frank Coe's New Englander Corn & Potato Fertilizer
1163	E. Frank Coe's New Englander Corn & Potato Fertilizer
1027	E. Frank Coe's Red Brand Excelsior Guano
1179	E. Frank Coe's Red Brand Excelsior Guano
1055	E. Frank Coe's Standard Potato Fertilizer
1176	E. Frank Coe's Standard Potato Fertilizer
	DEEP COVE MANUFACTURING CO., EASTPORT, ME.
1399	Fish & Potash
	ESSEX FERTILIZER CO., BOSTON, MASS.
1445	Essex Complete Manure for Corn, Grain & Grass
1324	Essex Complete Manure for Potatoes, Roots & Vegetables
1419	Essex Complete Manure for Potatoes, Roots & Vegetables
1446	Essex Market Garden & Potato Manure
1373	Essex Peerless Potato Manure
1413	Essex Peerless Potato Manure
1447	Essex XXX Fish & Potash
	HUBBARD FERTILIZER CO. BALTIMORE, MD.
1365	Hubbard's Aroostook Special Fertilizer for Potatoes and all other crops
1368	Hubbard's Aroostook Special Fertilizer for Potatoes and all other crops
1298	Hubbard's Blood, Bone & Potash
1296	Hubbard's Bone & Potash, 10 and 2
1297	Hubbard's Farmers' I. X. L.
1295	Hubbard's 5% Royal Seal Compound

Analysis of Station Samples, 1909.

Station number.	Nitrogen. As Ammonia.	Nitrogen. As Nitrates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1353	0.21	1.73	3.48	3.28	4.00	2.91	2.42	6.91	6.00	9.33	7.00	10.20	10.00
1417	0.22	1.59	3.16	3.28	3.91	3.14	1.91	7.05	6.00	8.96	7.00	9.24	10.00
1407	0.14	1.76	3.96	4.10	3.62	4.87	2.36	8.49	8.00	10.85	9.00	8.13	7.00
1418	0.14	1.93	3.79	4.10	4.35	4.02	2.32	8.37	8.00	10.69	9.00	8.36	7.00
1058	0.17	......	1.68	1.65	4.62	3.12	2.39	7.74	8.00	10.13	9.00	4.93	4.00
1168	0.15	......	1.65	1.65	4.69	2.71	0.85	7.40	8.00	8.25	9.00	3.89	4.00
1291	0.26	......	1.56	1.65	3.54	3.58	1.05	7.12	8.00	8.17	9.00	4.61	4.00
1054	0.19	......	1.34	1.23	6.58	2.45	0.93	9.03	8.50	9.96	9.50	3.47	2.50
1164	0.14	......	1.01	1.23	5.28	2.72	0.76	8.00	8.50	8.76	9.50	3.03	2.50
1177	0.17	......	1.16	1.23	5.50	2.59	0.76	8.09	8.50	8.85	9.50	2.87	2.50
1287	0.16	......	1.10	1.23	4.23	4.03	1.79	8.26	8.50	10.05	9.50	2.61	2.50
1194	2.07	......	3.40	3.70	3.59	3.01	1.33	6.60	7.00	7.93	8.50	12.04	10.00
1292	0.25	......	3.60	3.70	6.30	1.33	0.74	7.63	7.00	8.37	8.50	9.70	10.00
1017	0.21	0.59	2.32	2.47	2.63	4.39	2.88	7.02	7.00	9.90	8.00	6.20	8.00
1288	0.17	......	1.97	2.47	4.99	2.08	0.79	7.07	7.00	7.86	8.00	8.10	8.00
1051	......	......	......	......	3.25	6.42	1.02	9.67	10.00	10.69	11.00	2.53	2.00
1165	......	......	......	......	3.52	5.98	0.66	9.50	10.00	10.16	11.00	2.24	2.00
1065	0.10	......	0.92	0.80	4.67	4.98	0.93	9.65	8.50	10.58	10.00	1.89	1.50
1178	0.20	......	1.09	0.80	5.66	3.25	0.66	8.91	8.50	9.57	10.00	1.81	1.50
1008	0.16	......	1.88	1.85	5.01	3.25	0.83	8.26	8.00	9.09	9.00	2.86	3.00
1290	0.19	......	1.71	1.85	4.59	3.00	0.96	7.59	8.00	8.55	9.00	3.37	3.00
1060	0.16	......	2.38	2.47	6.57	3.33	0.45	9.90	8.00	10.35	9.00	6.22	6.00
1161	0.71	......	2.21	2.47	4.75	2.53	1.17	7.28	8.00	8.45	9.00	6.29	6.00
1052	0.12	......	0.84	0.80	4.53	3.31	0.59	7.84	7.50	8.43	8.50	2.82	3.00
1163	0.12	......	0.86	0.80	3.96	3.58	0.64	7.54	7.50	8.18	8.50	3.21	3.00
1027	0.18	......	3.18	3.30	7.83	1.54	1.01	9.37	8.00	10.38	9.00	6.73	7.00
1179	0.99	......	2.98	3.30	4.86	3.49	1.14	8.35	8.00	9.49	9.00	9.66	7.00
1055	0.69	......	2.90	3.30	4.65	1.42	0.88	6.07	6.00	6.95	7.00	9.00	10.00
1176	0.72	......	2.66	3.30	2.74	2.22	1.66	4.96	6.00	6.62	7.00	10.33	10.00
1399	0.09	1.47	3.36	3.29	3.72	3.59	0.66	7.31	6.00	7.97	......	11.41	10.00
1445	0.09	.....	3.21	3.26	5.14	1.57	1.34	6.71	6.00	8.05	7.00	10.16	10.00
1324	0.18	0.70	3.40	3.25	4.75	1.84	1.51	6.59	6.00	8.10	7.00	10.31	10.00
1419	0.12	0.58	3.26	3.25	5.17	2.01	1.24	7.18	6.00	8.42	7.00	10.42	10.00
1446	0.16	......	1.85	2.00	6.54	1.49	1.22	8.03	8.00	9.25	9.00	1.95	5.00
1373	0.13	......	4.32	4.00	5.47	2.81	1.29	8.28	7.00	9.57	8.00	7.57	8.00
1413	0.48	......	4.04	4.00	4.78	2.91	2.04	7.69	7.00	9.73	8.00	8.36	8.00
1447	0.11	......	2.06	2.00	5.57	3.02	1.49	8.59	8.00	10.08	9.00	2.98	3.00
1365	1.20	1.01	3.66	3.71	5.49	2.02	0.98	7.51	7.00	8.49	8.00	10.12	10.00
1368	0.11	0.39	3.50	3.71	5.90	2.44	0.96	8.34	7.00	9.30	8.00	9.61	10.00
1298	0.10	0.96	3.38	3.32	4.75	3.12	1.22	7.87	8.00	9.09	9.00	6.72	7.00
1296	......	......	......	......	1.16	9.14	2.62	10.30	10.00	12.92	11.00	2.71	2.00
1297	1.10	......	1.46	1.66	2.23	6.01	1.62	8.24	8.00	9.86	9.00	2.83	2.00
1295	1.90	......	4.00	4.15	1.04	5.02	1.47	6.06	6.00	7.53	7.00	5.63	5.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
1461	Hubbard's Royal Ensign
1366	Hubbard's Special Potato Compound
	LISTER'S AGRICULTURAL CHEMICAL WORKS, NEWARK, N. J.
1102	Lister's Animal Bone and Potash
1264	Lister's Animal Bone and Potash
1108	Lister's High Grade Special for Spring Crops
1266	Lister's High Grade Special for Spring Crops
1101	Lister's Oneida Special
1215	Lister's Oneida Special
1015	Lister's Potato Manure
1213	Lister's Potato Manure
1105	Lister's Special Corn Fertilizer
1217	Lister's Special Corn Fertilizer
1098	Lister's Special Potato Fertilizer
1216	Lister's Special Potato Fertilizer
1067	Lister's Success Fertilizer
1267	Lister's Success Fertilizer
1103	Lister's 10% Potato Grower
1214	Lister's 10% Potato Grower
	MERROW BROS. & CO., AUBURN, ME.
1438	Merrow's Bone Meal
	MORRISON BROS., BANGOR, ME.
1117	Acid Phosphate
1123	Morrison Bros. "C" Brand Fertilizer for All Crops
1464	Morrison Bros. "C" Brand Fertilizer for All Crops
1122	Morrison Bros. "A" Brand Potato Fertilizer
1118	Muriate of Potash
1120	Nitrate of Soda
1119	Sulphate of Potash
	NATIONAL FERTILIZER CO., BOSTON, MASS.
1371	Chittenden's Ammoniated Bone Phosphate
1372	Chittenden's Aroostook Special
1351	Chittenden's Aroostook Special
1377	Chittenden's Complete Root Fertilizer
1416	Chittenden's Eureka Potato Fertilizer
1398	Chittenden's Excelsior Potato Fertilizer
1376	Chittenden's Market Garden Fertilizer
	NEW ENGLAND FERTILIZER CO., BOSTON, MASS.
1137	New England Complete Manure
1333	New England Complete Manure
1424	New England Complete Manure
1134	New England Corn & Grain Fertilizer
1335	New England Corn & Grain Fertilizer
1133	New England Corn Phosphate
1336	New England Corn Phosphate
1322	New England High Grade Potato Fertilizer
1380	New England High Grade Special
1383	New England High Grade Special

Analysis of Station Samples, 1909.

Station number.	Nitrogen. As Ammonia.	Nitrogen. As Nitrates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1461	0.12	1.46	2.47	2.49	3.37	3.89	1.16	7.26	8.00	8.42	9.00	5.01	4.00
1366	1.71	......	3.10	3.32	4.15	2.61	0.60	6.76	6.00	7.36	7.00	10.64	10.00
1102	......	......	......	......	3.35	7.06	3.71	10.41	10.00	14.12	11.00	1.94	2.00
1264	......	......	......	......	5.02	4.95	2.04	9.97	10.00	12.01	11.00	2.27	2.00
1108	0.05	0.69	2.00	1.65	5.42	3.58	3.38	9.00	8.00	12.38	9.00	9.94	10.00
1266	0.12	0.22	2.34	1.65	3.19	4.25	3.15	7.44	8.00	10.59	9.00	9.15	10.00
1101	0.18	0.07	1.14	0.83	2.98	4.78	2.80	7.76	7.00	10.56	8.00	1.23	1.00
1215	0.29	......	0.92	0.83	5.98	1.63	1.15	7.61	7.00	8.76	8.00	1.51	1.00
1015	0.18	1.06	3.68	3.30	5.95	2.41	2.47	8.36	8.00	10.83	9.00	6.61	7.00
1213	1.68	1.03	3.46	3.30	6.51	2.15	1.15	8.66	8.00	9.81	9.00	7.17	7.00
1105	0.19	0.58	2.26	1.65	6.26	2.87	2.44	9.13	8.00	11.57	9.00	3.35	3.00
1217	0.31	......	1.64	1.65	5.47	2.71	1.95	8.18	8.00	10.13	9.00	3.48	3.00
1098	0.14	0.39	2.26	1.65	6.44	2.69	2.44	9.13	8.00	11.57	9.00	3.40	3.00
1216	0.31	......	1.78	1.65	5.23	2.77	1.89	8.00	8.00	9.89	9.00	3.33	3.00
1067	0.12	0.18	1.76	1.23	5.48	3.28	2.83	8.76	9.00	11.59	11.00	2.18	2.00
1267	0.19	......	1.44	1.23	6.11	2.94	2.04	9.05	9.00	11.09	11.00	2.21	2.00
1103	0.06	1.32	2.97	3.30	4.34	2.74	1.52	7.08	6.00	8.60	7.00	10.55	10.00
1214	2.27	......	3.07	3.30	4.86	1.46	1.02	6.32	6.00	7.34	7.00	10.31	10.00
1438	0.04	......	1.48	1.25	......	......	......	......	......	29.56	31.00	......	......
1117	......	......	......	......	14.63	2.03	0.22	16.66	16.00	16.88	......	......	......
1123	0.07	0.43	2.46	2.20	8.63	1.75	0.27	10.38	10.00	10.65	......	5.81	6.00
1464	0.08	0.96	1.97	2.20	7.58	1.39	0.98	8.97	10.00	9.95	......	5.87	6.00
1122	0.07	0.98	3.88	3.00	7.58	0.90	0.40	8.48	8.00	8.88	......	9.90	10.00
1118	......	......	......	......	......	......	......	......	......	......	......	49.96	50.00
1120	......	......	15.40	15.00	......	......	......	......	......	......	......	......	......
1119	......	......	......	......	......	......	......	......	......	......	......	50.52	48.00
1371	0.13	0.06	1.86	1.65	4.58	3.91	2.55	8.49	8.00	11.04	10.00	2.69	2.00
1372	0.09	2.05	4.00	4.11	4.18	3.60	1.28	7.78	7.00	9.06	8.00	7.06	7.00
1351	0.15	0.08	4.32	4.11	5.30	2.19	1.98	7.49	7.00	9.47	8.00	6.89	7.00
1377	0.22	1.33	3.12	3.30	3.57	4.46	2.05	8.03	8.00	10.08	10.00	5.50	6.00
1416	0.82	0.33	2.72	2.40	4.94	1.92	1.15	6.86	6.00	8.01	7.00	9.36	10.00
1398	0.14	1.65	3.16	3.30	3.30	3.51	1.40	6.81	6.00	8.21	7.00	10.41	10.00
1376	0.20	......	2.72	2.40	6.01	2.27	1.82	8.28	6.00	10.10	8.00	4.93	5.00
1137	0.10	......	3.18	3.28	4.39	2.54	1.22	6.93	6.00	8.15	7.00	10.69	10.00
1333	0.12	0.20	3.13	3.28	4.45	2.36	1.02	6.81	6.00	7.83	7.00	10.60	10.00
1424	0.15	0.14	3.36	3.28	5.26	1.31	0.51	6.57	6.00	7.08	7.00	10.08	10.00
1134	0.05	......	1.22	1.22	6.11	0.89	1.05	7.00	7.00	8.05	8.00	2.22	2.00
1335	0.08	......	1.35	1.22	5.50	1.63	1.15	7.13	7.00	8.28	8.00	2.16	2.00
1133	0.07	......	1.46	1.64	6.06	2.23	1.34	8.29	8.00	9.63	9.00	5.03	3.00
1336	0.07	......	1.52	1.64	5.82	2.51	1.59	8.33	8.00	9.92	9.00	3.42	3.00
1322	0.13	......	2.26	2.46	5.90	2.12	1.25	8.02	8.00	9.27	9.00	5.90	6.00
1380	0.28	......	3.66	3.69	6.09	1.47	1.74	7.56	7.00	9.30	8.00	10.31	10.00
1383	0.55	......	3.66	3.69	5.02	2.33	1.10	7.35	7.00	8.45	8.00	10.31	10.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
1382	New England Market Garden Manure
1414	New England Market Garden Manure
1131	New England Potato Fertilizer
1321	New England Potato Fertilizer
1205	New England Potato Grower
1337	New England Potato Grower
1139	New England Superphosphate
1327	New England Superphosphate
	PARMENTOR & POLSEY FERTILIZER CO., BOSTON, MASS.
1328	P. & P. "A. A." Brand
1385	P. & P. "A. A." Brand
1396	P. & P. "A. A." Brand
1384	P. & P. Aroostook Special
1427	P. & P. Aroostook Special
1326	P. & P. Maine Potato Fertilizer
1430	P. & P. Maine Potato Fertilizer
1329	P. & P. Plymouth Rock Brand Fertilizer
1334	P. & P. Special Potato Fertilizer for all Root Crops
	E. W. PENLEY, AUBURN, MAINE.
1435	Penley's Best Potato Fertilizer
	PORTLAND RENDERING CO., PORTLAND, ME.
1294	Bone Dust Tankage
	PROVINCIAL CHEMICAL FERTILIZER CO., ST. JOHN, N. B.
1422	Special Potato Phosphate
1350	10% Complete Aroostook Potato
1402	10% Complete Aroostook Potato
	P. H. REED, FT. FAIRFIELD, MAINE.
1391	Reed's Potato Grower
	SAGADAHOC FERTILIZER CO., BOWDOINHAM, ME.
1309	Acid Phosphate
1312	Acid Phosphate
1306	Aroostook Potato Manure
1308	Dirigo Fertilizer
1431	Dirigo Fertilizer
1303	4-6 & 10 Potato Fertilizer
1429	4-6 & 10 Potato Fertilizer
1311	Muriate of Potash
1313	Nitrate of Soda
1448	Sagadahoc High Grade Superphosphate
1449	Sagadahoc High Grade Superphosphate
1304	Special Potato Fertilizer
1305	3-6 & 10 Potato Fertilizer
1428	3-6 & 10 Potato Fertilizer
1450	XX Chemical Brand
1307	Yankee Fertilizer

Analysis of Station Samples, 1909.

Station number.	Nitrogen. As Ammonia.	Nitrogen. As Nitrates.	Nitrogen. Total. Found.	Nitrogen. Total. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Potash. Found.	Potash. Guaranteed.
1382	0.11	0.38	3.88	4.10	5.50	3.01	1.28	8.51	7.00	9.79	8.00	6.95	7.00
1414	0.13	0.30	4.04	4.10	5.30	3.20	1.66	8.50	7.00	10.16	8.00	7.00	7.00
1131	0.07	......	1.56	1.64	4.37	2.94	0.94	7.31	7.00	8.25	8.00	5.13	4.00
1321	0.07	......	1.46	1.64	4.59	2.36	1.14	6.95	7.00	8.09	8.00	4.34	4.00
1205	0.18	......	2.18	2.46	4.86	1.96	1.15	6.82	6.00	7.97	7.00	10.61	10.00
1337	0.10	......	2.48	2.46	5.07	1.95	1.08	7.02	6.00	8.10	7.00	9.83	10.00
1139	0.09	......	2.19	2.46	6.41	2.21	1.40	8.62	8.00	10.02	10.00	3.75	4.00
1327	0.08	......	2.16	2.46	6.32	1.92	1.57	8.24	8.00	9.81	10.00	3.92	4.00
1328	0.14	0.12	4.36	4.10	5.58	2.37	1.43	7.95	7.00	9.38	8.00	7.73	8.00
1385	0.14	0.37	3.96	4.10	5.02	2.63	2.13	7.65	7.00	9.78	8.00	10.52	8.00
1396	0.18	0.43	4.34	4.10	4.82	3.15	1.28	7.97	7.00	9.25	8.00	8.75	8.00
1384	0.17	0.23	3.82	3.69	4.63	2.20	1.22	6.83	7.00	8.05	8.00	10.54	10.00
1427	0.11	0.19	3.50	3.69	5.53	2.28	1.17	7.81	7.00	8.98	8.00	10.47	10.00
1326	0.04	0.50	3.30	3.28	4.71	1.63	1.59	6.34	6.00	7.93	7.00	10.43	10.00
1430	0.12	0.12	3.40	3.28	5.02	1.94	0.97	6.96	6.00	7.93	7.00	9.92	10.00
1329	0.21	......	2.30	2.46	5.90	2.28	1.15	8.18	8.00	9.33	9.00	4.28	4.00
1334	0.10	0.06	3.22	3.28	6.38	1.95	1.37	8.33	8.00	9.70	9.00	7.27	7.00
1435	0.15	1.31	1.80	2.47	1.48	2.10	0.41	3.58	6.00	3.99	7.00	8.15	10.00
1294	0.26	......	5.16	5.75	......	......	......	......	......	17.58	14.50	......	......
1422	0.47	......	2.26	2.06	5.38	1.71	0.96	7.09	8.00	8.05	......	10.07	6.00
1350	1.05	......	2.70	3.29	5.55	1.26	0.96	6.81	8.00	7.77	......	9.01	10.00
1402	1.14	......	2.42	3.29	5.18	1.48	0.84	6.66	8.00	7.50	......	9.90	10.00
1391	0.10	1.70	3.18	3.30	5.55	1.82	0.84	7.37	7.00	8.21	8.50	7.31	8.00
1309	......	......	......	......	10.88	4.32	0.18	15.20	15.00	15.38	......	......	......
1312	......	......	......	......	10.61	4.00	1.66	14.61	15.00	16.27	......	......	......
1306	0.24	0.15	1.24	1.00	2.55	2.55	1.49	5.10	6.00	6.59	7.00	3.24	4.00
1308	0.13	0.05	2.56	1.00	2.46	2.71	1.05	5.17	4.00	6.22	6.00	4.34	2.00
1431	0.06	......	2.80	1.00	2.07	3.44	0.82	5.51	4.00	6.33	6.00	3.31	2.00
1303	0.23	1.35	2.62	3.29	1.44	4.81	2.83	6.28	6.00	9.11	7.00	10.21	10.00
1429	0.23	......	2.90	3.29	2.52	3.31	1.27	5.83	6.00	7.10	7.00	9.63	10.00
1311	......	......	......	......	......	......	......	......	......	......	......	50.68	50.00
1313	......	......	15.28	14.00	......	......	......	......	......	......	......	......	......
1448	0.15	0.52	3.22	1.50	2.27	4.02	2.51	6.29	6.00	8.80	7.00	3.32	3.00
1449	0.09	0.37	2.65	1.50	5.26	3.92	1.47	9.18	6.00	10.65	7.00	2.04	3.00
1304	0.22	0.56	1.58	2.00	1.95	4.99	2.95	6.94	7.00	9.89	8.00	9.52	8.00
1305	0.17	1.35	2.40	2.47	2.23	3.89	1.57	6.12	6.00	7.69	7.00	9.59	10.00
1428	0.32	1.63	2.80	2.47	1.80	4.23	2.55	6.03	6.00	8.58	7.00	9.70	10.00
1450	0.09	......	6.90	7.00	0.16	5.99	5.01	6.15	4.00	11.16	6.00	11.59	8.00
1307	0.04	0.38	0.56	0.40	1.39	7.28	2.51	8.67	7.00	11.18	8.00	5.10	2.00

Descriptive List of Station Samples, 1909.

Station number.	Manufacturer, place of business and brand.
	SWIFT'S LOWELL FERTILIZER CO., BOSTON, MASS.
1125	Swift's Lowell Animal Brand
1319	Swift's Lowell Animal Brand
1129	Swift's Lowell Bone Fertilizer
1316	Swift's Lowell Bone Fertilizer
1320	Swift's Lowell Cereal Fertilizer
1315	Swift's Lowell Dissolved Bone & Potash
1437	Swift's Lowell Empress Brand
1317	Swift's Lowell Potato Manure
1440	Swift's Lowell Potato Manure
1135	Swift's Lowell Potato Phosphate
1443	Swift's Lowell Potato Phosphate
1136	Swift's Potato Grower
1318	Swift's Potato Grower
1410	Swift's Potato Grower
1439	Swift's Special Corn & Vegetable Manure
1130	Swift's Special Potato Fertilizer
1331	Swift's Special Potato Fertilizer
1206	Swift's Superior Fertilizer with 10% Potash
1332	Swift's Superior Fertilizer with 10% Potash
	F. W. TUNNELL & CO., PHILADELPHIA, PA.
1444	Wizard Potato Manure
	TUSCARORA FERTILIZER CO., BALTIMORE, MD.
1386	Tuscarora Aroostook Special
1395	Tuscarora Aroostook Special
1462	Tuscarora Fruit & Potato
1390	Tuscarora Trucker
1412	Tuscarora Trucker
	JOHN WATSON & CO., HOULTON, ME.
1346	Watson's Improved Potato Fertilizer
	WHITMAN & PRATT RENDERING CO., LOWELL, MASS.
1451	Whitman & Pratt's Potash Special
1456	Whitman & Pratt's Potash Special
1452	Whitman & Pratt's Potato Plowman
1453	Whitman & Pratt's Vegetable Grower
1458	Whitman & Pratt's Vegetable Grower

Analysis of Station Samples, 1909.

Station number.	Nitrogen.				Phosphoric Acid.							Potash.	
	As Ammonia.	As Nitrates.	Total. Found.	Total. Guaranteed.	Soluble.	Reverted.	Insoluble.	Available. Found.	Available. Guaranteed.	Total. Found.	Total. Guaranteed.	Found.	Guaranteed.
1125	0.10	......	2.12	2.46	6.68	1.70	1.35	8.38	8.00	9.73	10.00	3.77	4.00
1319	0.10	......	2.36	2.46	6.67	2.14	1.19	8.81	8.00	10.00	10.00	4.15	4.00
1129	0.05	......	1.53	1.64	6.12	2.31	1.31	8.43	8.00	9.74	9.00	3.35	3.00
1316	0.12	......	1.40	1 64	5.74	2.41	1.59	8.12	8.00	9.74	9.00	3.19	3.00
1320	0.16	......	0.88	0.82	5.23	2.36	1.02	7.59	7.00	8.61	8.00	1.29	1.00
1315	0.12	......	1.66	1.64	6.16	2.37	3.13	8.53	9.00	11.66	10.00	2.57	2.00
1437	0.06	......	1.26	1.23	5.69	1.73	1.03	7.42	7.00	8.45	8.00	2.17	2.00
1317	0.07	......	1.34	1.64	4.59	1.71	1.28	6.30	7.00	7.58	8.00	4.22	4.00
1440	0.07	......	1.30	1.64	4.31	2.68	1.19	6.99	7.00	8.18	8.00	4.05	4.00
1135	0.09	......	2.14	2.46	6.44	1.90	1.10	8.34	8.00	9.44	9.00	6.50	6.00
1443	0.08	......	2.20	2.46	6.09	2.14	1.37	8.23	8.00	9.60	9.00	6.07	6.00
1136	0.11	0.08	3.36	3.28	4.05	4.00	1.14	8.05	6.00	9.19	7.00	10.31	10.00
1318	0.12	......	3.13	3.28	4.71	1.80	1.34	6.51	6.00	7.85	7.00	10.33	10.00
1410	0.05	1.76	3.24	3.28	3.94	2.44	0.96	6.38	6.00	7.34	7.00	9.80	10.00
1439	0.15	1.77	3.10	3.28	6.30	1.78	1.49	8.08	8.00	9.57	9.00	6.82	7.00
1130	0.09	......	2.37	2.46	5.79	1.38	1.24	7.17	6.00	8.41	7.00	10.42	10.00
1331	0.10	......	2.26	2.46	4.90	1.53	0.87	6.43	6.00	7.30	7.00	10.40	10.00
1206	0.22	0.06	3.50	3.69	5.60	2.36	0.37	7.96	7.00	8.33	8.00	10.52	10.00
1332	0.21	0.57	3.88	3.69	5.42	1.58	1.05	7.00	7.00	8.05	8.00	10.34	10.00
1444	0.75	......	2.76	3.29	4.51	3.43	1.63	7.94	8.00	9.57	9.00	9.46	10.00
1386	0.11	0.13	2.50	2.47	5.87	1.15	0.64	7.02	7.00	7.66	8.00	7.29	8.00
1395	0.10	0.90	2.36	2.47	5.42	1.69	0.47	7.11	7.00	7.58	8.00	7.21	8.00
1462	0.07	0.77	0.84	1.65	6.46	1.90	0.92	8.36	8.00	9.28	9.00	11.05	10.00
1390	0.63	0.85	3.86	4.11	7.18	1.44	0.92	8.62	8.00	9.54	9.00	6.74	7.00
1412	1.08	......	4.06	4.11	7.02	1.42	1.10	8.44	8.00	9.54	9.00	6.84	7.00
1346	0.31	0.40	4.22	4.12	6.54	1.82	1.08	8.36	8.00	9.44	10.00	6.62	7.00
1451	0.18	......	2.55	2.87	1.90	4.81	3.74	6.71	6.00	10.45	8.00	11.73	10.00
1456	0.13	......	2.73	2.87	3.25	3.71	2.50	6.96	6.00	9.46	8.00	11.45	10.00
1452	0.16	......	3.05	3.29	2.41	6.28	3.32	8.69	7.00	12.01	9.00	6.99	6.00
1453	0.19	......	3.28	3.29	2.66	6.53	4.24	9.19	8.00	13.43	10.00	7.38	7.00
1458	0.10	0.31	2.87	3.29	4.24	4.94	4.11	9.18	8.00	13.29	10.00	7.46	7.00

LIST OF PRINCIPAL STATION PUBLICATIONS IN 1909.

WORK OF INVESTIGATION. (BULLETINS.)

No. 164. Notes on Plant Diseases, 1908.
No. 165. Poultry Notes.
No. 166. Inheritance of Fecundity in Poultry.
No. 167. Field Experiments in 1906 to 1908.
No. 168. The Fertility and Hatching of Eggs.
No. 169. Two Epidemics of Potato Blight and Rot.
No. 170. Apple Diseases caused by *Coryneum follicum* and *Phoma mali.*
No. 171. Pine Leaf and Green Winged Chermes.
No. 172. Fungus Gnats, Part I.
No. 173. Chermes of Maine Conifers.
No. 174. Blackleg: A Bacterial Disease of Potatoes.
No. 175. Meteorology, Finances and Index.

WORK OF INSPECTION. (OFFICIAL INSPECTIONS.)

No. 7. Standards for Beverages.
No. 8. Bleached Flour, Benzoate of Soda, Sulphur Dioxide, Ice Cream Standards and Flavoring Extracts.
No. 9. Analyses of Manufacturers' Samples of Fertilizers.
No. 10. Analyses of Concentrated Commercial Feeding Stuffs.
No. 11. Soda. Cream of Tartar, Sweet Corn, Maple Sugar, Spices, Pepper, Spirit of Nitrous Ether, Rice and Alcohol.
No. 12. Text of the laws regulating the sale of:—Agricultural Seeds, Apples, Creamery Glassware, Feeding Stuffs, Fertilizers, Food, and Drugs.
No. 13. Coffee, Gelatin, Sweet Oil, Honey.
No. 14. Standards and Regulations under Food and Drug Law.
No. 15. Apples, Catchup, Cocoa, Extracts, Spirit of Nitrous Ether and Oysters.
No. 16. Commercial Thickeners for Ice Cream, Jams, Jellies, and Preserves.
No. 17. Analyses of Agricultural Seeds.
No. 18. Analyses of Drugs. The Druggist and the Law.

All correspondence relative to the laws regulating the sale of apples, food and drugs, feeding stuffs, fertilizers, seeds and creamery glassware, should be addressed to

Director CHAS. D. WOODS,
Orono, Maine.

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

FEEDING STUFF INSPECTION.

There are here reported the analyses of samples of feeding stuffs submitted, chiefly by dealers, May to December, 1909. In the samples thus submitted protein alone was determined. These samples were taken in accordance with the Station directions and whenever samples were received that fell below the guaranty new samples from at least six packages were requested. Only one analysis out of the same car is here reported, in each case it being the highest so as to give all benefit of doubt to the goods. In some instances the analyses represent cars that were refused by the dealers and sent out of the State. So far as known, in all instances where lots fell below the guaranty and were accepted, the guarantees were changed to accord with actual analyses.

These results are printed at this time without comment in order that they may be promptly before all handlers of feeding stuffs and in the hands of feeders. The usual winter inspection is being made by the Station and the results of the analyses of the official samples will be reported in a number of Official Inspections that will probably be ready for distribution in May.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
COTTON SEED MEAL.				
Cotton Seed Meal	41.00	41.00	9.00	2888
American Cotton Oil Co., Jackson, Tenn	39.87	41.00	9.00	2890
	39.25	41.00	9.00	2939
Huntsville, Ala	42.00	41.00	9.00	2889
Memphis, Tenn	42.93	41.00	9.00	2891
	41.13	41.00	9.00	2151
	42.19	41.00	9.00	2162
Battle Brand Cotton Seed Meal	42.25	41.00	8.00	2875
W. P. Battle & Co., Memphis, Tenn	42.50	41.00	8.00	2927
	42.81	41.00	8.00	2957
Cotton Seed Meal	41.37	41.00	7.00	2873
H. E. Bridges & Co., Memphis, Tenn	41.75	41.00	7.00	2902
	41.00	41.00	7.00	2907
	41.50	41.00	7.00	2930
	38.13	38.50	7.50	2156
	42.37	41.00	7.00	2158
	42.81	41.00	7.00	2161
Buckeye Cotton Seed Meal	38.87	39.00	–	2884
Buckeye Cotton Oil Co.	43.00	39.00	–	2024
	41.13	39.00	6.50	2033
	37.29	39.00	–	2060
	42.88	39.00	6.50	2061
	41.37	39.00	6.50	2063
	40.75	39.00	–	2064
	39.56	39.00	–	2065
	41.06	39.00	–	2066
	40.69	39.00	6.50	2067
	41.00	39.00	–	2069
	40.87	39.00	–	2070
	38.80	39.00	7.00	2074
	39.31	39.00	5.00	2075
	39.75	39.00	6.50	2083
	40.25	39.00	6.50	2088
	41.00	39.00	6.50	2089
	40.88	39.00	6.50	2090
	41.34	39.00	6.50	2092
	41.69	39.00	–	2094
	39.63	39.00	6.50	2095
	40.63	39.00	–	2125
	40.75	39.00	–	2133
	40.13	39.00	6.50	2140
	41.88	39.00	6.50	2105
	39.87	39.00	6.50	2117
	41.63	39.00	6.50	2121
	38.00	39.00	6.50	2163
Dixie Brand Cotton Seed Meal	41.00	38.50	6.00	2878
Humphreys Godwin & Co., Memphis, Tenn	43.37	38.50	6.00	2900
	39.87	41.00	8.00	2923
	43.25	38.50	6.00	2925
	42.25	38.50	6.00	2926
	40.69	38.50	6.00	2952
	38.87	41.00	–	2966
	39.13	41.00	7.00	2968
	39.00	41.00	–	2969
	41.63	41.00	8.00	2988
	40.69	38.50	6.00	2993
	43.57	38.50	7.00	2006

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
COTTON SEED MEAL—Continued.				
Dixie Brand Cotton Seed Meal—Continued.	40.31	41.00	6.50	2020
	42.94	38.50	–	2026
	38.54	38.50	–	2028
	37 37	38.50	–	2034
	40.44	38.50	–	2035
	40.44	38.50	–	2037
	42.88	38.50	–	2038
	39.01	38.50	–	2042
	39.38	38.50	6.00	2046
	41.94	38.50	–	2047
	39.50	38.50	7.00	2048
	38.19	38.50	7.00	2049
	40.75	38.50	7.00	2050
	37.94	38.50	6.00	2059
	37.94	38.50	7.00	2068
	39.87	38.50	6.00	2076
	35.90	38.50	7.00	2077
	38.94	38.50	7.00	2080
	37.75	38.50	7.00	2081
	38.25	38.50	7.00	2082
	39.00	38.50	7.00	2084
	36.13	38.50	7.00	2086
	39.63	38.50	7.00	2123
	34.38	38.50	7.00	2126
	38.87	38.50	7.00	2134
	37.00	38.50	7.00	2139
	37.75	38.50	7.00	2147
	39.75	38.50	7.00	2152
	42.81	38.50	7.00	2165
Good Luck Brand Cotton Seed Meal............................	44.19	38.00	9.00	2109
S. P. Davis, Littlerock, Ark..................................	46.75	38.00	7.50	2115
Green Diamond Brand Cotton Seed Meal......................	41.56	41.00	8.00	2085
Chapin & Co., Boston, Mass..................................	43.19	41.00	8.00	2106
	43.46	41.00	8.00	2113
	42.56	41.00	8.00	2118
	41.37	41.00	8.00	2130
	42.25	41.00	8.00	2157
Hunter Brothers' Prime Cotton Seed Meal.....................	39.35	41.00	7.50	2870
Hunter Bros. Milling Co., St. Louis, Mo......................	38.87	41.00	7.50	2874
	41.37	41.00	7.50	2905
	42.25	41.00	7.50	2933
	35.75	38.50	6.00	2943
	41.63	41.00	7.50	2004
	38.57	38.50	6.50	2029
	39.13	38.50	–	2036
	42.38	41.00	7.50	2116
	41.56	41.00	7.50	2124
	41.20	41.00	7.50	2129
	42.75	41.00	7.50	2131
	41.75	41.00	7.50	2135
	41.50	41.00	7.50	2136
	41.81	41.00	7.50	2137
	43.94	41.00	7.50	2141
	42.31	41.00	7.50	2146
	44.50	41.00	7.50	2150
	44.37	41.00	7.50	2160
Choice Cotton Seed Meal..	41.00	41.00	9.00	2051
Rodney J. Hardy & Sons, Boston, Mass......................	43.88	41.00	–	2977

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
COTTON SEED MEAL—Continued.				
Old Gold Cotton Seed Meal	40.63	41.00	9.00	2871
T. H. Bunch Co., Littlerock, Ark	41.37	41.00	9.00	2877
	38.63	41.00	9.00	2881
	37.87	41.00	9.00	2882
	38.18	41.00	9.00	2883
	38.25	41.00	9.00	2887
	41.00	41.00	9.00	2904
	37.25	41.00	9.00	2955
	38.37	41.00	9.00	2963
	36.50	41.00	–	2964
Owl Brand Cotton Seed Meal	41.75	41.00	6.00	2880
F. W. Brode & Co., Memphis, Tenn	43.00	41.00	6.00	2885
	42.75	41.00	6.00	2886
	42.50	41.00	6.00	2892
	41.63	41.00	6.00	2912
	44.37	41.00	6.00	2938
	42.29	41.00	6.00	2079
	43.00	41.00	6.00	2087
	45.88	41.00	6.00	2108
	41.32	41.00	6.00	2110
	42.81	41.00	6.00	2114
	45.13	41.00	6.00	2127
	43.69	41.00	6.00	2123
	44.00	41.00	6.00	2138
Purity Brand Cotton Seed Meal	42.13	41.00	9.00	2876
J. T. Walker, Broker, Memphis, Tenn	41.50	41.00	9.00	2896
	40.25	41.00	9.00	2991
	39.19	41.00	9.00	2032
	44.19	41.00	–	2104
Soper's Prime Cotton Seed Meal	41.56	38.50	–	2010
J. E. Soper & Co., Boston, Mass	40.44	41.00	–	2143
Star Brand Cotton Seed Meal	39.06	41.00	9.00	2953
J. Lindsay Wells Co., Memphis, Tenn	40.56	41.00	9.00	2985
	42.85	41.00		2023
	39.75	41.00	9.00	2107
Wyandotte Cotton Seed Meal	42.89	41.00	7.00	2007
Kansas City Cotton Meal Products Co.				
COTTON SEED FEED.				
Star Cotton Feed	16.50	10.00	6.50	2940
Toledo Elevator Co., Toledo, O.				
LINSEED OIL MEAL.				
Linseed Oil Meal	38.00	36.00	1.00	2932
American Linseed Co., Chicago, Ill	35.00	36.00	1.00	2945
Old Process Oil Meal	38.37	32.00	5.00	2895
American Linseed Co., Chicago, Ill	36.50	32.00	5.00	2097
Old Process Oil Meal	24.75	34.00	6.50	2918
Hunter Bros. Milling Co., St. Louis, Mo.				

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
GLUTEN FEED.				
Bay State Gluten Feed	21.51	22.00	4.00	2981
J. E. Soper & Co., Boston, Mass.				
Buffalo Gluten Feed	25.25	23.00	2.50	2894
Corn Products Refining Co., Chicago, Ill.	27.13	23.00	–	2929
	28.13	23.00	2.00	2934
	25.37	23.00	2.50	2958
	27.13	23.00	2.50	2970
	28.06	23.00	2.50	2974
	26.75	23.00	2.50	2975
	27.13	23.00	2.50	2982
	28.38	24.00	2.50	2986
	26.81	24.00	2.50	2012
	28.01	24.00	4.50	2014
	27.13	24.00	4.50	2015
	26.88	24.00	4.50	2016
	28.01	24.00	4.50	2017
	27.94	24.00	4.50	2018
	27.69	24.00	4.50	2019
	25.31	24.00	2.50	2021
	27.25	–	–	2045
	28.19	24.00	2.50	2053
	27.73	24.00	2.50	2101
	26.00	24.00	2.50	2148
Cream of Corn Gluten Feed	24.13	23.00	2.50	2928
American Maize Products Co., New York, N. Y.	24.50	23.00	2.50	2948
	27.50			2962
	27.06	23.00	2.50	2990
	26.18	23.00	2.50	2998
	26.38	23.00	2.50	2999
	27.50	23.00	2.50	2052
	28.62	23.00	2.50	2159
Crescent Gluten Feed	26.62	23.00	2.50	2971
Corn Products Refining Co., Chicago, Ill.	26.19	–	–	2044
Golden Rod Gluten Feed	27.00	–	–	2956
Norton Chapman Co., Portland, Me.	27.88	27.00	4.00	2027
	27.88	–	–	2040
Gluten Feed	26.38	23.00	2.50	2009
Rodney J. Hardy & Son, Boston, Mass.				
Gluten Feed	26.40	23.50	2.60	2997
J. C. Hubinger Bros. Co., Keokuk, Iowa.				
Jenk's Gluten Feed	23.88	25.00	2.50	2917
Huron Milling Co., Harbor Beach, Mich.	24.50	25.00	2.50	2949
	23.69	25.00	2.50	2959
	22.00	23.00	3.00	2972
	22.88	–	–	2979
	25.88	23.00	3.00	2149
Royal Gluten Feed	23.50	20.00	2.00	2921
Globe Elevator Co., Buffalo, N. Y.	20.13	23.00	2.00	2944
	21.50	20.00	2.00	2951

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein.		Fat guaranteed.	Station number.
	Found.	Guaranteed.		
DISTILLERS GRAINS.				
Ajax Flakes	27.37	–	–	2973
Ajax Milling and Feed Co., Milwaukee, Wis	32.37	–	–	2008
Dearborn Distillers Dried Grains	22.69	22.00	8.00	2058
J. W. Biles Co., Cincinnati, Ohio	23.21	22.00	8.00	2099
Fourex	29.25	31.00	12.00	2013
J. W. Biles Co., Cincinnati, Ohio	30.25	31.00	12.00	2072
	30.60	31.00	–	2119
WHEAT OFFALS.				
Adrian Flour Washburn Mills Co.	20.00	17.00	5.00	2915
Adrian Mixed Feed Detroit Milling Co., Detroit, Mich.	15.63	–	–	2901
Badger Red Dog Badger Chittenden Milling Co., Milwaukee, Wis.	18.75	18.00	4.00	2914
Gwinn's Dairy Feed	15.75	–	–	2961
Sleepy-eye Pure Wheat Feed Sleepy-eye Milling Co.	16.00	16.00	4.50	2937
XXX Comet Feed Flour Consolidated Milling Co.	18.00	–	–	2916
ADULTERATED WHEAT OFFALS.				
Jersey Mixed Feed Indiana Milling Co.	14.13	10.00	2.50	2984
BEEF SCRAPS.				
Beef Scraps	41.75	–	–	2898
Portland Rendering Co., Portland	39.50	35.00	10.00	2919
Bone and Meat Meal Portland Rendering Co., Portland.	39.37	35.00	8.00	2976
MISCELLANEOUS COMPOUND FEEDS—Protein over 20%.				
Unicorn Dairy Ration	25.25	26.00	6.00	2978
Ajax Milling and Feed Co., Milwaukee, Wis	26.02	26.00	6.00	2996
	23.76	26.00	6.00	2003
	26.31	26.00	6.00	2022
Union Grains	26.19	24.00	7.00	2994
J. W. Biles Co., Cincinnati, Ohio	24.25	24.00	7.00	2056
	23.80	24.00	7.00	2096

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
MISCELLANEOUS COMPOUND FEEDS—Protein 15-20%.				
Badger Dairy Feed	17.69	16.00	–	2002
Chas. A. Krause Milling Co., Milwaukee, Wis.	16.63	–	–	2031
	16.00	16.00	3.50	2073
	17.97	16.00	3.50	2132
Eaco Winged Horse Mixed Feed Everett Aughenbaugh, Nasua, Minn.	17.44	15.00	3.00	2111
King Mixed Feed Moore Milling Co, Princeton, Ill.	18.25	15.00	–	2992
Mixed Feed Noblesville, Milling Co.	15.81	15.00	4.00	2947
Quaker Dairy Molasses Feed	15.06	16.00	3.50	2030
Quaker Oats Co., Chicago, Ill.	15.25	16.00	3.50	2103
Husted Molasses Feed Husted Milling Co., Buffalo, N. Y.	20.50	18.00	–	2120
Schumaker's Calf Meal Quaker Oats Co., Chicago, Ill.	19.00	19.00	8.00	2946
Sucrene Dairy Feed American Milling Co.	16.88	16.50	3.50	2144
Sugarota Dairy Feed	17.63	18.00	8.00	2893
North West Mills Co., Winona, Minn.	16.88	18.00	1.50	2942
	15.93	18.00	4.00	2980
	14.31	18.00	4.50	2995
	16.81	16.00	3.00	2054
	16.00	16.00	3.00	2154
XXX Dairy Feed	22.25	17.00	3.00	2921
Milwaukee Grain & Feed Co., Milwaukee, Wis.	19.94	15.00	2.50	2090
MISCELLANEOUS COMPOUND FEEDS—Protein 10-15%.				
Champion Mixed Feed Portland Milling Co.	14.75	–	–	2967
Cumberland Mills Co. Oat Feed Cumberland Mills Co., Cumberland Junc.	10.06	–	–	2039
Dairy Winter Mixed Feed Henry Jennings, Boston, Mass.	11.44	11.00	3.00	2001
H. O. Co's Algrane Horse Feed H. O. Co., Buffalo, N. Y.	11.71	12.00	1.50	2908
H. O. Co's Algrane Milk Feed H. O. Co., Bnffalo, N. Y.	18.13	14.00	4.00	2909
Schumaker's Dairy Feed Quaker Oats Co., Chicago, Ill.	11.81	10.00	1.00	2100

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper.	Protein. Found.	Protein. Guaranteed.	Fat guaranteed.	Station number.
MISCELLANEOUS COMPOUND FEEDS—Protein 10-15%—Concluded.				
Schumaker's Stock Feed Quaker Oats Co., Chicago, Ill.	11.13 9.38 10.00 9.63	10.00 10.00 – 10.00	4.00 4.00 – 4.00	2911 2935 2983 2987
Schumaker's Oat Feed Quaker Oats Co., Chicago, Ill.	10.56	–	–	2041
Sucrene Horse and Mule Feed American Milling Co.	10.63	10.00	3.00	2145
MISCELLANEOUS COMPOUND FEEDS—Protein under 10%.				
Corn and Oat Chop Feed Norton Chapman Co., Portland.	7.63	–	–	2903
Ground Oats Husted Milling Co.	9.81	–	–	2112
Haskell's Oat Feed W. H. Haskell & Co.	9.94	–	–	2043
H. O. New England Stock Feed H. O. Co., Buffalo, N. Y.	9.13	9.00	4.00	2910
Pearl Horse & Cow Feed Chapin & Co., Boston, Mass.	8.13	6.00	3.00	2899
Star Feed Toledo Elevator Co., Toledo, Ohio.	8.38	7.00	6.50	2913
Winner Chop Feed David Stott, Detroit, Mich.	9.63	8.00	4.00	2936
MISCELLANEOUS.				
Purina Alfalfa Meal Purina Mills Co., St. Louis, Mo.	15.38	15.00	15.00	2920
Pea Hull Meal Michigan Cereal Co., Ubly, Mich.	14.63	17.15	1.45	2879

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Official Inspections.

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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

SHORT WEIGHT CREAMERY BUTTER.

November 25, 1909, C. W. Stevens, Deputy Sheriff, Oldtown, wrote that he had weighed four "bricks" of creamery butter at an Oldtown store and that the four tipped the scales at just 3 pounds and 8 ounces. This was sold to the dealer at 35 cents per pound. To this price he added one cent for express and sold the butter for 40 cents. The butter actually cost the user 45 cents per pound.

The same day the deputy was sent to Oldtown and visited several places where butter was on sale and made up records from the goods in stock as per the following statement copied from his note book:

Creamery Butter Examined for Weight in Oldtown, November 26.

Lunt's Cash Market, Chas. E. Lunt, Main Street.

Kineo, 5 lbs. averages .7 oz. short with carton. Bought 5 packages.

Yorkshire. Up to weight.

Gray's Market, Main Street.

Kineo, 5 lbs. averaged .6 oz. short with carton.

L. Alford, Main Street.

Handles only dairy butter.

Saulsbury's Market, A. D. Saulsbury, Main Street.

Handles mostly Kineo but had none in stock. Said that they weigh the lots as received. Last lot they had was up to weight; one before was considerably short.

Sawyer & Rand, Main Street.

Yorkshire. Up to weight.

Old Town Supply Co., C. J. McLeod, Main Street.

From Corinth Creamery, bought of Russell Bros., Bangor. Up to weight.

Yorkshire. Up to weight.

Five pounds of the Kineo Butter made by the Maine Creamery Association of Bangor was purchased at Lunt's Cash Market. These were entered as No. 8669 and weighed without the cartons but with the parchment paper 4.54 pounds.

A hearing was appointed which developed that the manager of the Maine Creamery Association had been absent for three months; that before going away he purchased a set of high grade scales and instructed his butter maker to frequently weigh their output so as to make sure that it was full weight. To this the butter maker also makes affidavit. On investigation, however, they find that one of the several blocks of the power print was short and this had escaped their observation. The affidavits were accepted and the case not prosecuted.

WHAT IS CIDER VINEGAR?

According to the standard, vinegar without a qualifying word, in Maine, always means Apple Cider Vinegar. It must be made exclusively from undiluted apple juice and must be sufficiently well fermented so that it shall contain not less than 4 per cent by weight of acetic acid. Based upon the examination of large numbers of samples of pure vinegar the standard also states that a cider vinegar shall:—

Deflect polarized light to the left; contain not less than 1.6 per cent apple solids; not more than half of the apple solids shall be reducing sugars; contain not less than .25 per cent of

apple ash; and the water soluble ash shall contain not less than certain definitely stated amount of phosphoric acid and shall possess a certain alkalinity.

As stated in Bulletin 151 there is more or less general opinion among some of the manufacturers and large handlers of vinegars that there are on the market spurious cider vinegars which are sold in competition with the genuine article. In order to give this matter a test quite a large number of samples of vinegar coming from large manufacturers, chiefly outside of the State, were given extended examination and at the same time quite an extended study was made of what we were reasonably confident were strictly pure, home made cider vinegars. The results were presented in Bulletin 151 of this Station. The conclusion was reached in the bulletin that while some vinegars were more or less suspicious there was no greater departure from a normal cider vinegar in case of vinegars coming from the large manufacturers than in the case of home produced cider vinegars.

Again in 1909 one of the large shippers of vinegar into Maine called the attention of the Station to this matter. They stated that there was a large amount of so-called cider vinegar being distributed throughout Maine which was practically acetic acid and boiled cider flavored with acetic ether. They suggested the names of several wholesale houses where this type of vinegar could be found. Three samples of these vinegars were obtained, apparently from three entirely different sources. These samples were sent, together with a cider vinegar of known purity but marked abnormality, to an "expert" in Boston who had gained a large experience through his "over twenty-five years examination of many thousands of samples while inspector for the City, and analyst for the Mass. State Board of Health." These samples were sen. in similar packages and with no distinguishing marks other than our numbers. His report contained the chemical tests and the conclusion that "I do not find that any one of them conforms to the requirement of being the legitimate product of pure apple juice, or made exclusively from apple cider." The sample of cider vinegar made from cider from hand pressed Milding and Snow apples, by slow fermentation without addition of any kind, by the Director of the Station and carefully transferred without sediment to glass

carboys for his personal use, was reported as having high acidity (6.2 per cent) and found "to be very different from the other four, not having even the share of cider stock they do, in fact little of it, being but a grossly poor imitation of a true cider vinegar."

The fact seems to be that while the great majority of cider vinegars will conform to the standard as fixed in Maine and explained above, it is certain that occasionally vinegar made from pure apple juice will depart even to a marked extent from these definitions. In the case of the cider vinegar made by the Director of this Station, if it had been found in the open market and nothing known of its history, we should have reached the same conclusion as the Boston analyst to whom it was referred. While it is easy to distinguish between cider vinegar and other types of vinegar it is not possible to always detect a manipulated vinegar from a straight vinegar. Nor does it seem possible to strictly follow the standards without running the risk of prosecuting an entirely innocent person. All vinegar, whether cider or other kinds, must be up to strength or else plainly marked "Below Standard." While we shall continue to investigate all suspicious vinegars, we shall until such time as we may be able to distinguish more closely than now seems possible, continue to pass as cider vinegars such as seem to bear evidence of being made from apples even if they do not conform to all the minor requirements.

RESULTS OF INSPECTION OF VINEGAR.

It was found in the fall of 1905 that vinegars of all kinds, and all degrees of strength, were being sold throughout the State under the name of "cider vinegar." In the summer of 1906 another inspection was made, and while there was still a good deal of trouble, the vinegar situation had vastly improved. In the summer of 1907 practically no misbranded vinegars were found in the hands of the dealers, although country vinegars of poor quality were found. In other words, in the three years the situation as to vinegar had so far improved that the retailer knew what he was buying from the wholesale dealer. In 1908 samples were collected by the inspector without his making himself known. In a large number of instances he was given

straight cider vinegar, but in altogether too large numbers, as shown by the analysis and subsequent investigation, he was given a substitute. In the summer of 1909 samples of vinegar were again purchased by the deputy, without his making himself known to the dealer, from quite a number of stores in towns that had not been previously visited. It is gratifying to note that only 4 different lots of vinegar were obtained that were not in accord with the law, and that in three of these instances it was a mistake of the clerk.

According to the jobbers the sale of distilled vinegars artificially colored in imitation of cider vinegar which were so common in the State five years ago has practically stopped. There has been an increase, however, in the amount of sugar vinegar which is being sold. Sugar vinegar is made from dark colored sugar house syrups or from sugar containing burned sugar (caramel). This so-called sugar vinegar is naturally colored because of the impurities so that in appearance it more or less resembles cider vinegar. Sugar vinegar is not as desirable an article as distilled vinegar which it is replacing. It is doubtful if any sugar vinegar would be sold if the consumer realized what he was getting. In the majority of cases, even though it be labeled, it is probable that because of its color the consumer thinks that he is getting cider vinegar. The consumer who does not care for cider vinegar had better purchase uncolored distilled vinegar. Distilled vinegar is free from coloring matter, contains nothing but acetic acid and water, and is suited for table use, and is particularly adapted for keeping pickles. Most people, however, are fond of the flavor of cider vinegar of good quality, and it is now possible in all parts of the State to buy such vinegar.

While under the standards the word "vinegar" used by itself in Maine always means apple cider vinegar, it may happen that dealers will deliver sugar vinegar or possibly distilled vinegar artificially colored when only vinegar is asked for. Therefore the person who wants cider vinegar should always be sure and ask for *cider* vinegar.

The results of the analyses of vinegar follow.

Table showing the kind of vinegar and the results of the chemical analyses of goods that were delivered to the Station Inspector when he bought cider vinegar from the retailer.

Station number.	Name and Address of Dealer.	Total acid.	Total solids.	Ash.
	CIDER VINEGAR.	%	%	%
8472	A. M. Penley & Co., Auburn	4.35	2.72	0.37
8473	Dunn & Ross, Auburn	4.20	2.19	0.33
8474	Arthur W. Penley, Auburn	4.29	2.71	0.35
8475	Olfene's Spot Cash Market, Auburn	4.26	2.25	0.30
8476	Perryville Cash Market, Auburn	4.37	2.20	0.38
8477	O. F. Holmes, Auburn	4.73	2.09	0.37
8461	Hooker & Wallace, Bath	4.85	3.34	0.38
8462	W. H. Sweet, Bath	4.98	2.42	0.34
8463	Cash Market Co., Bath	4.20	1.85	0.28
8464	H. L. & W. E. Chase, Bath	4.68	2.27	0.38
8465	F. Wilbur Brown, Bath	4.58	1.94	0.33
8466	Geo. F. Wallace, Bath	4.14	1.62	0.42
8585	E. M. Chase, Brownville	5.04	2.34	0.27
8507	A. H. Berry & Son, Houlton	4.68	2.70	0.32
8508	L. W. Dyer, Houlton	4.59	2.60	0.38
8509	Robinson Grocery Co., Houlton	4.31	2.31	0.27
8510	E. A. Gillin & Co., Houlton	4.41	2.39	0.29
8511	McGary Bros., Houlton	4.22	2.35	0.27
8512	Emerson Bros., Island Falls	4.16	2.39	0.29
8513	Frank W. Hunt & Co., Island Falls	4.58	2.53	0.31
8514	J. C. & B. C. Walker, Island Falls	4.20	2.35	0.27
8478	Langelier & Lavertu, Lewiston	4.86	2.23	0.31
8480	Spear & Webster, Lewiston	4.17	1.64	0.29
8481	Atwood's Market, Lewiston	4.38	2.34	0.30
8482	A. P. Conant, Lewiston (1)	2.70	1.81	0.31
8483	J. Bowker, Lewiston	4.20	2.00	0.33
8503	A. C. Smart, Millinocket	4.22	2.22	0.32
8504	McAvey & Smart, Millinocket	4.39	2.48	0.32
8505	Union Cooperative Store, Millinocket	4.10	2.18	0.32
8587	Henry Cotter Co., Milo	5.04	1.95	0.27
8588	M. G. Brockett, Milo	5.09	2.02	0.28
8589	Cottle & Peakes, Milo	5.04	2.02	0.27
8515	H. M. Tozier, Patten	4.82	2.36	0.38
8516	Quincy, Cooper & Rowe, Patten	4.44	2.62	0.32
8450	Ingraham's Market, Rockland	4.34	2.13	0.29
8451	Francis Cobb & Co., Rockland	4.73	1.53	0.26
8452	W. T. Duncan, Rockland	4.22	2.06	0.26
8453	H. J. Fitch, Rockland	4.26	2.09	0.29
8454	Ferrand, Spear & Co., Rockland	4.22	2.13	0.34
8455	C. M. Tibbetts, Rockland	4.77	2.60	0.42
8484	The Waterville Market, Ernest Crosby, Waterville	4.91	2.16	0.32
8485	McCallum's, Waterville	4.29	2.19	0.28
8486	Elmwood Market, Waterville	4.25	2.25	0.32
8487	Brown & Sturtevant, Waterville	3.96	1.82	0.35
8488	Whitcomb & Cannon, Waterville	3.83	1.86	0.29
8489	W. P. Stewart & Co., Waterville	3.83	2.09	0.36
	DISTILLED VINEGAR, Colored to imitate cider vinegar.			
8479	E. J. Roche, Lewiston (2)	4.52	0.64	0.12
	SUGAR VINEGAR. Made from dark colored stock it resembles cider vinegar in appearance.			
8586	O. P. Gerry, Brownville (3)	4.89	1.54	0.22
8502	J. F. Kimball Trading Co., Millinocket (4)	4.74	2.39	0.27

(1) A good tasting cider vinegar, but too low in acid content. The case was investigated and there was no prosecution made.

(2) Hearing was appointed. Settled by affidavit.

(3) Hearing appointed. Mr. Gerry gave evidence that the vinegar was supplied to the deputy through the mistake of the clerk. Case settled by affidavit.

(4) Hearing appointed. Prosecution probable.

PORK SAUSAGE.

The gist of the regulations as regards the sale of pure and adulterated sausage is summed up in the following: — Pork sausage should be composed of minced, fresh pork to which salt, spices, and nothing else has been added. It should contain no larger amount of water than the meat from which it is made. Pork sausage true to name can be lawfully sold without labels. Pork sausage to which cereal, water, or anything else has been added needs to be labeled to show exactly what it is.

In the case of the manufacture of sausage it seems to be a fairly common practice to add more or less water. Some manufacturers state that they only add as much water as is necessary in order to make the sausage in such condition that they can be worked and put in the cases. While the addition of water softens the sausage, it is perfectly possible to make sausage from pure meat, salt and spices without the addition of water. Cereals, such as flour, are frequently added to pork sausage. Some of the spice mixtures sold for sausage flavoring are adulterated with cereal. It seems that cereal is added chiefly so that the sausage may hold more water. Thus it is possible to take 50 pounds of meat and 5 pounds of flour and add water enough to make 100 pounds of sausage. While it is doubtful if such an extreme adulteration is actually practiced, many cases have been found where large amounts of water are added. Most manufacturers who are using both cereal and water are labeling their sausage "cereal added." That, however, is not enough. Correct labeling of pork sausage to which cereal has been added and which contains more water than the meat from which the sausage is made is "Pork sausage, cereal and water added."

The food value of sausage depends upon the protein and fat. Both of these constituents have a direct relation to the water, and because of this mutual relation between fat, protein, and water it is easy to tell with considerable degree of accuracy whether or not sausage has been adulterated by the addition of water. Adulteration by the addition of cereal can be directly learned by the presence of starch which all cereals carry and which meat does not contain. Quite a large number of cases are now being investigated in which a pork sausage to which both water and cereal had been added was sold to the

deputy for pork sausage. There are still more cases in which sausages to which water had been added as well as cereal that were sold labeled "Pork sausage, cereal added."

The purpose of this article is to again call the attention of dealers to the fact that unless goods are exactly what they appear to be they must be correctly labeled when they are delivered to the purchaser. All imitation, substituted and adulterated goods must be correctly labeled so that the consumer will know exactly what he is getting.

COMPRESSED YEAST.

It has been more or less of a custom for the manufacturers of compressed yeast cakes to add starch so that much of the so-called compressed yeast that has been sold in the past was a mixture of yeast and starch. The United States Board of Food and Drug Inspection held a hearing last summer at which the manufacturers of yeast were present. As a result the Board has taken the following position:—

The Labeling of Yeast.

The term "compressed yeast," without qualification, means distillers' yeast without admixture of starch.

If starch and distillers' yeast be mixed and compressed such product is misbranded if labeled or sold simply under the name "compressed yeast." Such a mixture or compound should be labeled "compressed yeast and starch."

It is unlawful to sell decomposed yeast under any label.

The Sale of Compressed Yeast in Maine.

After April 1, 1910, the sale of compressed yeast in Maine must be made in conformity to the above requirements. It will not be enough that the goods be sold from packages properly labeled, but the yeast cake itself, if it contains starch or other foreign materials, must bear a label stating the exact facts. It will be lawful to sell without labeling and under the name "compressed yeast" yeast to which nothing has been added. All other yeasts which imitate compressed yeast, as above defined, must be correctly labeled when they are given to the consumer.

May, 1910

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Analysts

James M. Bartlett
Albert G. Durgin
Herman H. Hanson
Royden L. Hammond

Official Inspections.

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ICE CREAM — SODA WATER.

The attention of druggists, proprietors of restaurants and hotels, confectioners, and all others who dispense ice cream, soda, and carbonated beverages, is called to the regulations governing the sale of the same. Official Inspections 14 contains the text of the revised law and the regulations and standards applying to the above. Official Inspections 16 contains information in regard to ice cream thickeners, which is of particular interest to the makers of ice cream. Official Inspections 8 also explains in detail the regulations in regard to ice cream and ice cream substitutes. All who are interested in the manufacture or sale of either of the above are advised to acquaint themselves with these regulations at once.

Copies of the above publications will be furnished upon application and any additional information desired will be given as far as possible.

PORK SAUSAGE.

According to the standards adopted and fixed regulating the sale of food materials in Maine, sausage is defined as follows:—"Sausage, sausage meat is a comminuted meat from neat cattle or swine, or a mixture of such meats, either fresh, salted, pickled or smoked, with added salt and spices, and with or without the addition of edible animal fats, blood and sugar, or subsequent smoking. It contains no larger amount of water than the meats from which it is prepared contain when in their fresh condition, and if it bears a name descriptive of the kind, composition, or origin, it corresponds to such descriptive name. All animal tissues used as containers, such as casings, stomachs, etc., are clean and sound and impart to the contents no other substance than salt."

From this definition it follows that pork sausage must be composed of minced, fresh pork to which salt, spices, and nothing else has been added. It should contain no larger amount of water than the meat from which it is made.

Pork sausage plainly branded so as to show to the non-professional person a different standard of strength, quality and purity than the above definition would not be regarded as adulterated or misbranded, if it should be found to conform to its declared standard. Pork sausage true to name can be lawfully sold without labels of any kind. Pork sausage to which cereal, water, or anything else other than those materials mentioned in the definition, has been added needs to be labeled to show exactly what it is.

The table on pages 48 and 49 shows the results of the examination of materials which were bought for pork sausage by the deputy. When these goods were purchased the deputy did not make himself known but went to the store the same as any other customer would and asked for a pound of pork sausage. He took the materials as they were offered to him, noted explanations, if any, that the clerk made, made full records and copies of all labels, and passed the goods to the analysts for examination.

It will be noted that quite a large amount of the goods was adulterated either with water or cereal or both. In only one instance was the sausage thus adulterated properly labeled. On all of the violations hearings were appointed and the cases

investigated. In the majority of instances the dealer offered evidence, which was accepted to show that he was in the habit of labeling his sausage and that he had instructed his clerks to always label sausage. These statements were supported by affidavits from the proprietor, from the clerks, and from customers. For the most part the cases were settled without prosecution. In a few instances the cases are still pending.

The William G. Bell Company of Boston prepares seasoning for sausage, etc., which is quite largely used in this State. The Bell's Spice Seasonings are made from pure spices and nothing else. Beside this they make sausage dressing and other similar products to which cereal is added.

This distinction between Bell's seasoning and dressing seems not to be clearly understood even by people who have been using the Bell preparations for years. This is important to the manufacturers as one makes pure sausage while the other makes adulterated sausage.

In one instance starch was found in sausage to which the maker was confident cereal had not been added. He said, however, that he used the same machinery in the manufacture of all the sausage, either with or without cereal. He, therefore, made a lot of sausage to which cereal was added and immediately followed it by the manufacture of sausage which he supposed contained no cereal. There was enough left in the machinery to adulterate what he considered to be pure sausage. This is shown by the analysis which follows:—

No. 8755 starch declared, analyzed, dry matter 53.0 percent.; fat 36.0 percent.; protein 11.5 percent.; starch in considerable quantity was present.

No. 8756, supposed to be pure sausage but made in the same machinery in which the sausage with cereal added had been made analyzed as follows: dry matter 53.5 percent.; fat 37.2 percent.; protein 13.1 percent.; starch present.

Apparently little or no water was used in the manufacture of these goods. The higher protein in the sample in which cereal was not declared shows that it contained very much less cereal than did the other sample. Cereal was present, however, in sufficient quantity to constitute an adulteration. This means that in the manufacture of sausage the machinery which is used must be thoroughly cleaned after adulterated sausage is made before the manufacture of pure sausage is attempted.

Table showing the results of the examination of goods that were delivered to the station inspector when he bought pork sausage from the retailer.

Sta. No.	Town and Dealer	Price per lb	Dry matter	Fat	Protein	Cereal	Remarks
		ct	%	%	%		
8728	Augusta, E. W. Church	14	44.0	26.4	9.5	Present	Adulterated with water and cereal.
8727	Augusta. C. E. Daggett	14	46.6	30.6	10.1	Present	Adulterated with water and cereal.
8729	Augusta, E. Locke	13	50.2	31.5	11.6	Present	Adulterated with water and cereal.
8725	Augusta, Merrill Bros	20	74.2	33.7	6.9	Absent	Passed.
8726	Augusta, J. F. Turner	14	50.4	30.9	11.9	Trace	Adulterated with water.
8730	Augusta, Webber & Hewett	14	53.3	34.4	11.6	Slight trace	Passed.
8724	Augusta, L. S. Young	13	49.9	30.7	11.5	Present	Adulterated with water and cereal.
8710	Bangor, M. C. Baker	15	53.4	40.2	10.5	Absent	Passed.
8701	Bangor, Collins' Market	18	62.8	49.6	9.3	Absent	Passed.
8705	Bangor, Fickett's Market	15	66.1	54.3	10.0	Absent	Passed.
8720	Bangor, F. L. Frank	18	62.4	49.3	9.3	Absent	Passed.
8721	Bangor, Gallagher Bros	15	53.3	37.0	13.1	Absent	Passed.
8718	Bangor, A. W. Joy's Market	15	62.4	41.7	11.6	Absent	Passed.
8709	Bangor, Leighton's Market	15	57.2	42.8	10.8	Absent	Passed.
8702	Bangor, Lynch's Market	20	63.4	50.2	10.8	Absent	Passed.
8704	Bangor, A. R. Pickard	13	51.7	36.1	12.7	Present	Adulterated with cereal.
8708	Bangor, C. J. Rabenstein	20	39.4	30.7	10.0	Present	Adulterated with water and cereal.
8707	Bangor, Staples Cash Market	12	45.4	30.5	10.3	Present	Adulterated with water and cereal.
8703	Bangor, E. W. Wilds	15	60.8	44.3	12.9	Absent	Passed.
8706	Bangor, C. F. Winchester	15	58.3	42.8	12.9	Absent	Passed.
8758	Belfast, B. A. Spear	20	58.2	43.7	9.6	Present	Adulterated with cereal.
8759	Belfast, Fogg & Coombs	13	57.3	42.8	9.9	Present	Adulterated with cereal.
8749	Brunswick, E. M. Alexander	15	58.8	41.5	11.1	Present	Adulterated with cereal.
8748	Brunswick, Cash Market Co	12	66.2	49.2	7.6	Present	Adulterated with cereal.
8747	Brunswick, Nelson McFadden	14	68.5	50.1	7.8	Present	Adulterated with cereal.
8760	Camden, C. E. Beedy	15	62.1	48.2	10.4	Present	Adulterated with cereal.

Table showing the results of the examination of goods that were delivered to the station inspector when he bought pork sausage from the retailer.—Concluded.

Sta. No.	Town and Dealer	Price per lb	Dry matter	Fat	Protein	Cereal	Remarks
		ct	%	%	%		
8764	Lewiston, Atwood's Market	18	47.9	31.7	13.4	Absent	Passed.
8765	Lewiston, Cloutier's Market	14	71.6	51.2	7.9	Present	Adulterated with cereal.
8766	Lewiston, Palmer's Market	15	62.3	46.4	12.6	Present	Adulterated with cereal.
8761	Rockland, Ingraham's Market	15	45.8	31.1	10.4	Present	Adulterated with water and cereal.
8762	Rockland, H. G. Tibbetts & Co	18	62.6	49.1	11.4	Absent	Passed.
8578	Skowhegan, Arthur R. Jewett	15	52.1	41.0	-	Absent	Passed.
8579	Skowhegan, Jewett & Pennell	15	50.2	29.9	-	Present	Cereal sticker on package.
8676	Skowhegan, Simpson's Market	15	49.5	37.9	-	Trace	Passed.
8589	Waterville, Cen. Me. Cooperative Store	14	41.9	23.6	-	Present	Salesman stated sausage contained cereal.
8681	Waterville, Frank E. McCullum	12	46.4	29.9	-	Present	Adulterated with water and cereal.
8686	Waterville, C. W. Mower	15	58.0	43.4	-	Present	Sticker "pork sausage, cereal and water added."
8687	Waterville, Robinson's Market	13	55.3	40.9	-	Present	Adulterated with cereal.
8683	Waterville, W. B. Stewart & Co	13	62.0	47.9	-	Trace	Passed.

LARD.

Lard was purchased from opened packages in December, 1909, at the following stores and microscopic and chemical examination shows it to be free from foreign fats:—

No. 8677 Arthur E. Jewett, Skowhegan

No. 8674 Parker & Nay, Skowhegan

No. 8675 Simpson's Market, Skowhegan

No. 8688 Central Maine Cooperative Store, Waterville

No. 8690 Elmer L. Craig, Waterville

No. 8680 Frank E. McCallum, Waterville

No. 8685 C. W. Mower, Waterville

No. 8682 W. B. Stewart & Co., Waterville

No. 8684 Whitcomb & Cannon, Waterville

CURRANTS AND RAISINS.

Quite a large number of samples of these important dried fruits were purchased in different parts of the State. The goods that were purchased were all package goods. They were examined for weight, percentage of dry matter and for their condition as regards cleanliness, freedom from dirt and the presence of worms or worm excreta.

The following method was used for estimating the amount of dirt present in these goods:—

In the examination of currants and raisins the most important point to be considered was apparently the amount of unnecessary refuse or dirt contained in the goods. It seems impossible to make an exact determination of the refuse, but the following method gives an approximate amount and may be taken to show the best or most desirable brands in comparison with those which are apparently carelessly prepared.

One hundred and fifty grams of the fruit, as found, were taken and washed once with as little water as practicable. It was impossible to filter the residue on account of the syrupy condition of the wash water and so this was evaporated to a syrup and then dried in the oven for 25 hours (the same time as was used for drying to obtain total solids). The result gives the approximate total refuse which, of course, includes some sugar and some pieces of the fruit which ought not to be classed as dirt. The results vary considerably and the highest figures do not always represent the samples which contain the most dirt. This total refuse was burned to a white ash and the result gives approximately the mineral matter obtained by washing 150 grams of the fruit. These results show more nearly the difference in the goods, but dividing the mineral matter by the total refuse, to obtain the ratio of mineral matter to the total refuse, gives the best indication of those goods which, apparently carelessly prepared, contain the most mineral matter. This mineral matter represents, in excess of that contained in the best goods, the sand, small pebbles, sticks, pieces of stems, etc., found in the poor goods. This determination seems to give a better indication of the dirty, carelessly prepared goods than an ash determination on a sample of the goods themselves as found in the package because the amount of seeds would influence the ash content of a sample taken of

the total goods to considerable extent and, while the goods are all supposed to be well seeded, as a matter of fact, some of the best in appearance and finest in flavor contain more seeds than some of the more undesirable samples.

In the case of the dirty and wormy goods, hearings were appointed and the cases investigated. Not all of the cases are finished, but it is probable that no prosecutions will be made. The desire was to call the attention of the trade to the need of much greater care in the handling and the branding of these goods.

It seems that the currants are practically all imported from Greece where they are dried by spreading the fruit upon the sand. The common cask currants are spread upon the ground for curing and when they are imported are full of grit, very unclean and unsightly. These are cleaned by washing with cold water, rubbing with revolving brushes and passing over sieves. By means of the sieves the sand and the small stems are more or less completely separated. The larger stems and the larger stones are removed by hand. There is another kind of currants that are imported which have gone through a dry cleaning process, so-called, in Greece. These are higher priced and are of much better appearance.

Under the present conditions it is perhaps too much to ask that currants be much better than the best which are now found in the market. There is, however, a right to demand a correction in labeling. Many of the currants as put up in packages undoubtedly have been put through a cleaning process and in that sense are cleaned. They are not clean in the real meaning of the word. Such expressions as "Ready for immediate use" are also misleading and unlawful on many of these goods.

The investigations which resulted from the hearings have shown a disposition on the part of the trade to conform to the requirements of the law, to clean up the goods as far as possible and to remove objectionable statements from the packages, and probably no prosecutions will result from this first inquiry. The attention of the trade, both wholesale and retail, however, is earnestly called to this subject and they are warned that the law will be enforced on this class of goods.

Table showing the results of examination of currants and raisins purchased in February, 1910. The samples are arranged alphabetically by the brand.

Sta. No.	Brand, Maker, Town and State	Price cents	Weight as purchased. ozs.	Dry matter %	Remarks
	CURRANTS				
8775	"Acme Currants, Thoroughly Cleansed and Stemmed. Ready for Immediate use. One Pound."...	13	15.6	78.5	Not very clean. Short weight. Unlawful. Hearing appointed.
8771	"Chariot Brand Cleaned Currants. Imported from Greece."...	12	14.5	82.1	Condition fair. Passed.
8743	"Hatchet Brand Currants. Selected cleaned and packed by Twitchell-Champion Co., Portland, Me. and Boston, Mass."...	13	15.1	78.5	Fair condition. Few seeds. Passed.
8744	"Hellas Brand Cleaned Currants."...	15	14.3	80.1	Some seeds. Very dirty. Insect excretions. Unlawful. Hearing appointed.
8734	"Holly Cleaned Currants. Serial No. 9741."...	10	14.7	81.8	Seeds quite abundant. Dirty. Unlawful. Hearing appointed.
8773	"No. 16 Battleship Cleaned Currants. Thoroughly cleaned and ready for immediate use. The Hooven Mercantile Co., New York."...	13	14.8	80.5	Some dirt. Not ready for "immediate use." Misbranded. Hearing appointed.
8736	"Nymph Brand Cleaned Currants."	10	14.5	78.9	Dirty. Unlawful. Hearing app't'd.
8745	"Parthenon Brand Cleaned Currants."...	12	15.1	76.6	Quite dirty. Some seeds. Unlawful. Hearing appointed.
8731	"Royal Excelsior Brand Perfectly Cleaned Currants. Hills Bros. Co., New York."...	10	14.2	81.2	Good condition. Passed.
8769	"Wasonco Brand Cleaned Currants. Packed for Wason & Co., Boston."	13	14.7	86.5	Good condition. Passed.
	RAISINS				
8777	"Blue Ribbon Brand Fancy Seeded Raisins. Recleaned Muscatel. Fresno Home Packing Co., Fresno Cal. Serial No. 5238."...	10	14.8	84.7	Condition very good. Passed.
8742	"Commander Brand Seeded Raisins Packed by North Ontario Packing Co., Cal."...	10	15.6	82.3	Fair condition. Small raisins. Passed.
8733	"Daisy Brand Seeded Raisins. Packed for Conant-Patrick Co., Portland, Maine."...	10	15.3	81.5	Good condition. Passed.
8776	"Golden State Seedless Raisins, Hatchet Brand. Selected, Cleaned and Packed by the Twitchell-Champlin Co., Portland, Maine and Boston, Mass."...	10	15.1	82.0	Good condition. Passed.
8746	"Hatchet Brand Seeded Raisins. Packed in Cal. for Twitchell-Champlin Co., Portland, Maine"...	13	14.6	83.6	Good condition. Few seeds. Passed.
8772	"Ideal Not-a-Seed Raisins. Grown without seeds in central Cal. American Vineyard Co. Fresno, Cal."...	12	14.9	85.8	Condition very good. Passed.

Table showing the results of examination of currants and raisins purchased in February, 1910. The samples are arranged alphabetically by the brand.—Concluded.

Sta. No.	Brand, Maker, Town and State	Price cents	Weight as purchased ozs.	Dry matter %	Remarks
	RAISINS				
8735	"Marvel Brand Seeded Raisins. Packed for C. A. Weston Co., Portland, Maine."	13	15.6	80.2	Many seeds. Good flavor and condition. Passed.
8739	"Monogram Brand Seeded Raisins. Packed by J. B. Inderrieden Co., Fresno, Cal."	7	14.5	82.4	Dirty and uninviting, but passed.
8738	"Nonpareil Brand Seeded Raisins. Packed by J. B. Inderrieden Co., Fresno, Cal."	10	14.9	81.6	Condition fair. Passed.
8732	"Peony Brand Fancy Seeded Raisins. Packed for Fuller-Holway Co., Augusta, Maine."	6	15.4	82.6	Worm eaten. Live worms present. Unlawful. Hearing appointed.
8741	"Pheasant Brand Fancy Seeded Raisins. Selma Fruit Co., Selma, Cal."	8	14.9	82.4	Fair condition. Passed.
8768	"Red Pennant Brand Choice Seeded Raisins. Packed by Kings County Raisin and Fruit Co., Armona, Cal."	10	14.6	84.8	Fair condition. Passed.
8740	"Suffolk Brand Seeded Raisins. Packed by Silas Pierce & Co. Ltd., Boston, Mass."	13	15.2	81.3	Good condition. Passed.
8770	"Sugar Drop Seeded Muscatel Raisins, Fancy. Cal. Fruit Canners Assoc., Fresno, Cal. Serial No. 6623."	10	15.6	84.9	Good condition. Passed.
8737	"Tulip Brand Seed Raisins. Phoenix Packing Co., Fresno, Cal."	8	15.5	81.1	Good condition. Passed.
8774	"Victoria Muscatel Seeded Raisins, Fancy. Serial No. 7745."	13	15.9	84.5	Good condition. Passed.
8767	"Wasonco Fancy Seeded Raisins. Fancy Recleaned Muscatel Raisins. Packed for Wason & Co., Boston."	10	15.2	83.2	Fine condition. Passed.

PICKLES.

A small amount of alum and benzoate of soda is allowed in pickles in Maine provided the fact of its presence is plainly stated upon the package. In the case of bottled pickles which were examined and are here reported no adulteration or misbranding was found with the exceptions named below.

In the past three years bottled pickles have been purchased by the deputy at different places in the State, and while they have for the most part been found in conformity with the requirements of the law, investigation has developed that it frequently happens that pickles, as well as other shelf goods, are quite old before reaching the consumer. It sometimes happens that the jobbing house is not careful to so pile his goods as to distinguish between those which have been in stock for some considerable time and new purchases. Also the retailer in filling up his shelves is not always careful to sell off the old goods first. While bottled and canned goods do not deteriorate very rapidly, obviously it is to the advantage both of the consumer and the dealer that goods be handled in as fresh condition as possible.

The table which follows gives the results of the examination of samples of pickles purchased in Portland in the summer and fall of 1909. In four cases the goods were found to be in violation of the Maine Food and Drug Law. Hearings were appointed and on investigation it was found that these were old goods. On account of this fact the cases were dropped without prosecution.

Table showing results of examination of pickles purchased in Portland in the summer and fall of 1909. Samples arranged alphabetically by states and towns within the state where the Goods were made.

Sta. No.	State, Town, Maker and Brand	Prices cents	Jar capacity ozs.	Results of Examinations
8397	England, London. Cross & Blackwell, "Mixed Pickles."	35	19.4	No alum or preservatives found. Passed.
8400	Illinois, Chicago. Wm. Hemming & Co. "Sweet Gherkins. Extra Fine Pickles. Contain alum, benzoate of soda and tumeric."	10	10.6	Alum, benzoate of soda, turmeric found, but declared. Passed.

Table showing results of examination of pickles purchased in Portland in the summer and fall of 1909. Samples arranged alphabetically by states and towns within the state where the Goods were made.—Concluded.

Sta. No.	State, Town, Maker and Brand	Prices cents	Jar capacity ozs.	Results of Examinations
8366	Illinois, Chicago. Libby, McNeill & Libby. "Libby's Gherkins. Serial No. 288."	10	6.4	Alum found. No preservatives found. Unlawful. Old goods.
8375	Illinois, Chicago. Libby, McNeill & Libby. "Libby's Sour Gherkins. Serial No. 288."	10	6.4	No alum or preservatives found. Passed.
8389	Illinois, Chicago. Libby, McNeill & Libby. "Libby's Mixed Pickles. Serial No. 288."	10	6.4	Alum found. No preservatives. Unlawful. Old goods.
8372	Pennsylvania, Pittsburg. H. J. Heinz Co. "Heinz Sour Midgets. Serial No. 557."	30	11.6	No alum or preservatives found. Passed.
8379	Pennsylvania, Pittsburg. H. J. Heinz Co. "Heinz Sour Spiced Pickles. Serial No. 557	10	6.4	No alum or preservatives found. Passed.
8403	Pennsylvania, Pittsburg. H. J. Heinz Co. "Heinz Pickles Onions. Serial No. 557."	10	6.4	No alum or preservatives found. Passad.
8370	Pennsylvania, Pittsburg. Lutz & Schramm. "L. & S. Pickles, Gherkins. Serial No. 3159."	10	6.4	Alum found. No preservatives. Unlawful. Old goods.
8382	Pennsylvania, Pittsburg. Lutz & Schramm. "Sour Midgets. Diamond Brand. Serial No. 3159."	30	11.3	Alum found. No preservatives. Unlawful. Old goods.
8390	Mass., Boston. J. P. & B. Plummer "Gherkins, Pickles. Eastman Brand English Style, Prepared with alum."	10	15.4	Alum present. No preservatives. Alum declared. Passed.
8369	Michigan, Detroit. E. G. Dailey Co. "New England Brand Michigan Pickles. Sweet Gherkins. Vinegar contains sugar, tumeric, spices and benzoate of soda. Serial No. 7824."	10	13.0	Alum and benzoate of soda found. Declared. Passed.
8404	Michigan, Detroit. E. G. Dailey Co. "New England Brand Michigan Pickles. Sour Mixed."	10	12.0	No alum or preservatives found. Passed.
8405	Michigan, Detroit. E. G. Dailey Co. "New England Brand Michigan Pickles. Sour Mixed. Serial No 78." Alum declared	10	12.4	Alum found. Declared. No other chemical preservatives. Passed.
8373	Michigan, Detroit. The Williams Bros. Co. "Williams Sweet Mixed Pickles." Alum and benzoate of soda declared.	10	9.5	Alum and benzoate of soda found. Declared. Passed.
8384	Virginia, Richmond. Mrs. E. G. Kidd. "16 oz. Pin Money Pickles. Mixed." Alum declared	30	20.4	Alum found. No preservatives present. Passed.
8365	"Gold Seal Brand Midget Gherkins. Serial No. 1281."	10	7.8	No alum or preservatives found. Passed.

Lutz & Schramm Co., Pittsburg, and Libby, McNeill & Libby, Chicago, made affidavit that they do not now use alum in their pickles.

CANNED FRUITS.

In October, 1909, samples of apricots, cherries, peaches, pears, pineapple and strawberries were purchased in Portland in cans. The relation between price and weight of dry matter is interesting and important. For the most part the quality of the canned fruits was such as not to be questioned. All of the goods examined were found to be lawful and were passed.

Table showing the results of examination of canned fruits purchased in Portland, October, 1909.

Sta. No.	State, Town, Packer and Brand	Price cents	Weight: Total ozs.	Weight: Solids Flesh ozs.	Weight: Dry Matter ozs.	Remarks
	APRICOTS					
8627	Cal., San Francisco. Cal. Fruit Canners Assoc. "Mt. Hamilton Brand Fancy Quality Apricots"	20	30.1	19.0	7.9	No preservatives found. Quality good. Passed.
	CHERRIES					
8626	Cal., San Jose. Golden Gate Packing Co. "Cal. Violet Brand Royal Ann Cherries"...........	28	32.9	20.8	8.2	No preservatives found. Quality good. Passed.
	PEACHES					
8628	Cal. San Jose. Santa Clara Co. "Cal. Violet Brand Extra Standard Peaches"....................	24	31.0	20.4	6.1	No preservatives found. Quality good. Passed.
	PEARS					
8633	New Jersey, Cedarville. John E. Drament Co. "Defense Brand Pears. Packed in extra heavy syrup".........................	15	20.9	11.2	4.2	No preservatives found. Quality good. Passed.
	PINEAPPLE					
8631	Cal. San Francisco. Hunt Bros. Co. "Keystone Hawaiian Pineapple..............	20	25.1	16.9	6.6	No preservatives found. Quality fine. Passed.
8625	Maryland, Baltimore. Schall P'king Co. "Perry & Brooks Pineapple. Standard Quality"......	18	20.1	8.8	1.4	No preservatives found. Quality good. Passed.
8630	Maryland, Baltimore. Schall P'king Co. "Terrapin Brand Sliced Pineapple.".....................	18	19.7	9.2	1.3	No preservatives found. Quality good. Passed.
8632	New York, N. Y. Paul, Taylor, Brown Co. "Pineapple Chunks. Oriental Brand. Singapore"....	18	19.8	13.9	3.3	No preservatives found. Quality not very good. Coarse without much flavor. Passed.
	STRAWBERRIES					
8629	Maryland, Baltimore. W.F. Asson Canning Co. "Strawberries, Narraganset. Extra Preserved. Superior Quality."...............	18	22.1	7.4	6.3	No preservatives found. Quality good. Passed.

June, 1910

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
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Both the spirit and the letter of the Maine Inspection laws demand freedom from adulteration and truthful labeling.

FEEDING STUFF INSPECTION.

CHIEF REQUIREMENTS OF THE LAW.

The points of the law of most interest both to the dealer and consumer concisely stated, follow.

Kinds of Feed Exempt Under the Law. The law applies to all feeding stuffs *except* the following: hays and straws; whole seeds, meals, brans and middlings of wheat, rye, barley, oats, Indian corn, buckwheat and broom corn, sold separately; wheat bran and middlings mixed together and pure grains ground together.

Kinds of Feed Coming Within the Law. The principal feeds coming under the provisions of the law are linseed meals, cottonseed meals, cottonseed feeds, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, dried distiller's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, corn and oat

chops, corn and oat feeds, corn bran, ground beef or fish scraps, foods, poultry foods, stock foods, patented, proprietary and trademark stock and poultry foods, mixed feeds other than those composed solely of wheat bran and middlings mixed together or pure grains ground together, and all other materials of similar nature.

The Brand. Each package of feeding stuffs coming within the law shall bear, conspicuously printed, the following statements:

The number of net pounds contained in the package.
The name or trade-mark under which it is sold.
The name of the manufacturer or shipper.
The place of manufacture.
The place of business of manufacturer or shipper.
The percentage of crude protein.
The percentage of crude fat.

The Adulteration of Feeding Stuffs. If any foreign substances are added to whole or ground grain or wheat offals, the true mixture must be plainly marked upon the packages.

Penalties. The sale or offering for sale of feeding stuffs not properly branded, or containing a smaller percentage of protein and fat than are guaranteed, or of adulterated feeding stuffs, is punishable by a fine not exceeding $100 for the first, and $200 for each subsequent offense.

THE GUARANTY.

No prosecution will be made against any handler of feeding stuffs within the State provided he obtain at the time of purchase a *written guaranty* that the goods are in conformity with the law regulating their sale. Failure to obtain such a guaranty on the part of the dealer will be presumptive evidence that he is not sufficiently interested in the purity of the goods which he handles, and unless there are especially extenuating circumstances, the Director will feel it his duty to begin prosecution for a violation of the laws regulating the sale of concentrated commercial feeding stuffs.

Any form of guaranty covering the facts may be used. The *printed matter on the bag or the tags* accompanying the feeding stuff *will not be considered as a guaranty.* The guaranty to be valid must be signed in ink. The guaranty should identify and

may be attached to the bill of sale, invoice, bill of lading or other schedule giving the name and amount of feed stuff. In case of car load lots, the car number should appear.

In case the dealer cannot obtain a written guaranty from the parties from whom he purchases, the only safe thing is to take a sample from the car immediately on its arrival and before it is accepted, and send to the Experiment Station, together with the name of feed and manufacturer and the guarantees. A prompt free analysis will be made and results reported.

INSPECTION FOR 1909-10.

The last report on feeding stuffs, Official Inspections 20, gave the results of the examination of samples received from May to December, 1909. The results were published without comment in order that the report could be distributed promptly. The samples discussed in this number comprise those submitted by dealers and collected by the inspector from December, 1909, to April 15, 1910. The discussion which follows applies to both publications.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper	Source of Sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Station number.
COTTON SEED MEAL.						
Buckeye Cotton Seed Meal	D	39.06	39.00	–	6.50	2169
Buckeye Cotton Oil Co.,	D	38.87	39.00	–	6.50	2177
Cincinnati, Ohio	D	39.31	39.00	–	6.50	2179
	D	39.56	39.00	–	6.50	2183
	D	38.25	39.00	–	6.50	2187
	D	39.37	39.00	–	6.50	2190
	D	42.00	39.00	–	6.50	2225
	D	36.37	39.00	–	6.50	2226
	D	39.56	39.00	–	6.50	2231
	D	39.50	39.00	–	6.50	2232
	D	40.06	39.00	–	6.50	2250
	O	38.93	39.00	6 73	6.50	2296
	O	38.93	39.00	–	6.50	2299
	O	41.87	39.00	6.89	6.50	2310
	O	40.02	39.00	–	6.50	2319
	O	37.68	39.00	–	6.50	2386
	D	42.43	39.00	–	6.50	2427

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein.		Fat.		Station number.
		Found—per cent.	Guaranteed—per cent.	Found—per cent.	Guaranteed—per cent.	
Cotton Seed Meal	D	38.60	41.00	–	9.00	2186
American Cotton Oil Co.,	O	39.37	41.00	–	9.00	2323
Grenada, Miss.	O	38.75	41.00	7.99	9.00	2402
	O	37.87	41.00	8.59	9.00	2425
Cotton Seed Meal	D	39.43	38.50	–	6.00	2180
H. E. Bridges & Co., Memphis, Tenn.	D	40.56	41.00	–	7.00	2182
	D	41.06	41.00	–	7.00	2330
	D	42.68	41.00	–	7.00	2331
	D	41.75	41.00	–	7.00	2381
	D	40.75	41.00	–	7.00	2382
	O	39.18	41.00	–	7.00	2395
Cotton Seed Meal	D	42.00	41.00	–	–	2362
F. E. Morse & Co., Little Rock, Ark.	D	42.25	41.00	–	–	2363
	D	42.00	41.00	–	–	2364
Dixie Brand Cotton Seed Meal	D	42.18	38.50	–	7.00	2173
Humphreys-Godwin Co., Memphis, Tenn.	D	41.25	38.50	–	7.00	2178
	D	40.00	38.50	–	7.00	2193
	D	40.75	38.50	–	7.00	2198
	D	39.06	38.50	–	7.00	2213
	D	44.06	38.50	–	7.00	2228
	D	40.81	83.50	–	7.00	2249
	D	40.43	38.50	–	7.00	2251
	D	38.59	38.50	–	7.00	2252
	D	42.75	41.00	–	7.00	2253
	D	37.93	38.50	–	7.00	2259
	D	39.83	38.50	–	7.00	2260
	D	42.93	38.50	–	7.00	2263
	D	39.50	38.50	–	7.00	2264
	D	43.43	38.50	–	7.00	2265
	D	37.81	38.50	–	7.00	2266
	D	38.56	38.50	–	7.00	2267
	O	34.62	38.50	8.68	7.00	2293
	O	40.52	38.50	6.78	7.00	2308
	D	39.93	38.00	–	7.00	2334
	D	39.31	38.00	–	7.00	2335
	D	40.56	38.00	–	7.00	2336
	D	39.50	38.50	–	7.00	2338
	D	41.26	38.50	–	7.00	2357
	D	39.93	38.50	–	7.00	2358
	O	36.06	38.50	–	7.00	2389
	O	36.28	38.50	7.30	7.00	2408
	O	39.87	38.50	–	7.00	2411
	D	41.12	38.50	–	7.00	2418
	D	39.12	38.50	–	7.00	2421
	D	40.56	38.50	–	7.00	2422
	D	37.68	38.50	–	7.00	2423
	D	41.00	38.50	–	7.00	2424
	D	42.37	38.50	–	7.00	2426
Dove Brand Cotton Seed Meal	D	40.24	38.00	–	7.00	2214
F. W. Brode & Co., Memphis, Tenn.	D	39.93	38.00	–	7.00	2229
	O	39.00	38.00	8.30	7.00	2326
	D	40.99	38.00	–	7.00	2230
	D	40.25	38.00	–	7.00	2233
	D	39.56	38.00	–	7.00	2355
	D	39.12	38.00	–	7.00	2359
	D	37.00	38.00	–	7.00	2397
Green Diamond Brand Cotton Seed Meal	O	41.51	41.00	9.12	8.00	2284
Chapin & Co., Boston, Mass.						

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONTINUED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Sample number.
Hunter Brothers' Cotton Seed Meal	D	40.81	41.00	–	7.50	2172
Hunter Bros. Milling Co.,	D	43.62	41.00	–	7.50	2191
St. Louis, Missouri	D	41.50	41.00	–	7.50	2192
	D	41.43	41.00	–	7.50	2194
	O	41.50	41.00	7.83	7.50	2378
Imperial Cotto Brand Cotton Seed Meal	D	40.50	41.00	–	9.00	2174
Imperial Cotto Milling Co.	O	38.50	41.00	7.21	9.00	2322
Owl Brand Cotton Seed Meal	D	40.93	41.00	–	6.00	2185
F. W. Brode & Co., Memphis, Tenn.	D	40.43	41.00	–	6.00	2196
	D	41.56	41.00	–	6.00	2255
	D	42.56	41.00	–	6.00	2256
	D	42.31	41.00	–	6.00	2262
	D	41.18	41.00	–	6.00	2257
	D	39.75	41.00	–	6.00	2258
	O	42.50	41.00	7.81	6.00	2272
	D	41.31	41.00	–	6.00	2353
	D	41.25	41.00	–	6.00	2361
	D	41.00	41.00	–	6.00	2367
	D	40.87	41.00	–	6.00	2368
	O	43.75	41.00	–	6.00	2373
	O	42.87	41.00	–	6.00	2406
	D	42.06	41.00	–	6.00	2414
Prime Cotton Seed Meal	O	43.00	41.00	8.07	8.00	2307
C. C. Johnson & Co	O	39.50	41.00	–	8.00	2309
Star Brand Cotton Seed Meal	D	39.31	41.00	–	9.00	2195
J. Lindsay Wells Co., Memphis, Tenn.						
LINSEED OIL MEAL.						
Linseed Oil Meal	O	37.12	36.00	2.85	1.00	2216
American Linseed Co., Chicago, Ill.	O	37.06	36.00	–	1.00	2316
Old Process Oil Meal	O	33.75	32.00	5.96	5.00	2302
American Linseed Co., Chicago, Ill.	O	36.75	32.00	–	5.00	2396
GLUTEN FEED.						
Buffalo Gluten Feed	D	27.25	24.00	–	2.50	2175
Corn Products Refining Co., New York	O	26.56	23.00	2 69	2.50	2210
	O	26.06	24.00	–	2.50	2274
	O	28.06	24.00	–	2.50	2279
	O	27.00	23.00	–	2.50	2283
	O	28.12	24.00	–	2.50	2327
	O	25.25	24.00	–	2.50	2344
	D	24.75	24.00	–	2.00	2379
	D	24.00	24.00	–	2.50	2420
Cream of Corn Gluten	O	27.06	23.00	–	2.50	2237
American Maize Products Co.	O	24.17	23.00	2.54	2.50	2306
	O	25.87	23.00	–	2.50	2320
	D	27.37	23.00	–	2.50	2431

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—CONCLUDED.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein.		Fat.		Sample number.
		Found—percent.	Guaranteed—percent.	Found—percent.	Guaranteed—percent.	
Diamond Gluten Feed Corn Products Mfg. Co.	O	22.07	23.00	2.99	2.50	2277
Golden Rod Gluten Feed Norton-Chapman Co., Portland, Me.	O	26.25	27.00	4.45	4.00	2211
Jenk's Gluten Feed Huron Milling Co., Harbor Beach, Michigan	O O	22.88 25.50	23.00 23 00	5.55 3.36	3.00 3.00	2209 2346
K K K Gluten Feed J. C. Hubinger Bros. Co.	O	21.94	23.00	2.37	2.00	2295
Pekin Gluten Feed Corn Products Mfg. Co.,	O	24.94	23.00	2.03	2.50	2222

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

WEED SEEDS IN FEEDING STUFFS.

The oil meals and gluten feeds, the analyses of which precede, have never been found to contain weed seeds of any amount. The analyses of the feeding stuffs which are more or less likely to carry weed seeds, follow. In most cases the official samples have been tested for weed seeds, but rarely have the samples which have been sent in by correspondents been so tested. In case the feeds have not been tested, the fact is indicated by ** referring to the foot note. In no case was there an exact quantitative analysis made, but a general estimate of the number of the seeds were formed by the analyst. In no case were the weed seeds tested for vitality.

In the winter of 1908 quite an extended investigation was made relative to weed seeds in feeding stuffs in Maine. These results were published at considerable length in bulletin 156. It is not purposed to discuss only in a very general way, the matter of weed seeds in the present report.

On pages 69 and 70 is a list of the feeds found to contain whole weed seeds and the kinds of seeds identified.

ANALYSES OF SAMPLES OF FEEDING STUFFS.

Name of Feed and Manufacturer or Shipper	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—Percent.	Fat. Guaranteed—percent.	Weed seeds. Found—percent.	Station number.
DISTILLERS GRAINS.							
Ajax Flakes .... Ajax Milling & Feed Co........ Milwaukee, Wis.	O	31.00	31.00	–	12.00	None	2350
Bourbon Grains R.	O	31.75	28.90	10.36	9.80	Fragments	2391
Climax Grains........ Deutsch & Sickert Co. Milwaukee, Wis.	O	29.62	30.00	13.14	10.00	None	2238
Continental Gluten Feed, ... Continental Cereal Co. Peoria, Ill.	D	31.20	33.00	–	14.00	**	2167
	D	30.75	33.00	–	14.00	**	2176
Dearborn Distillers Dried Grains.... J. W. Biles Co., Cincinnati, Ohio	O	23.13	22.00	9.94	8.00	None	2223
Dewey Distillers Grains........ Dewey Bros. Co.	D	32.00	26.00	–	9.00	**	2428
WHEAT OFFALS, FEED FLOUR.							
Atlas Red Dog........ Atlas Flour Mills, Milwaukee, Wis.	O	19.00	18.00	–	4.70	**	2236
Daisy Flour Feed........ Pillsbury, Minneapolis, Minn.	O	18.32	16.00	–	4.50	**	2312
Red Dog Flour........ Crescent Mills Co.	O	16.44	14.50	–	4.50	**	2297
WHEAT OFFALS, MIDDLINGS.							
Crescent Middlings........ Crescent Milling Co.	O	17.44	17.32	–	–	**	2305
Daisy Flour Middlings........ Pillsbury, Minneapolis, Minn.	O	18.31	16.00	–	4.50	**	2303
Dwight Flour Mills Pure Wheat Flour Middlings. .... Dwight Flour Mills, Minneapols, Minn.	O	18.82	17.00	–	5.05	**	2404
Fancy White Middlings........ Wm A. Coombs Milling Co. Coldwater, Mich.	O	14.94	15.00	–	3.00	**	2304
Harter's Pure Wheat Middlings ..... Harter Milling Co.. .... Toledo, Ohio.	O	18.36	17.00	–	4.00	**	2318
	O	18.00	17.00	–	4.00	**	2324
Hunter Bros. Pure Winter Wheat... Middlings Hunter Bros. Milling Co., St. Louis.	O	16.50	16.00	–	4.00	**	2231

** Not tested for weeds.

C. from the feeder; D. from the dealer; M. from the manufacturer; and O. the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—Continued.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Weed seeds. Found—percent.	Station number.
Middlings. Ansted & Burke, Springfield, Ohio.	O	17.82	14.50	–	4.00	**	2371
Middlings. Washburn Crosby Co., Minneapolis	O	17.38	15.00	–	4.00	**	2393
Pure and Unadulterated B Middlings.	O	16.38	15.00	–	4.50	**	2270
Pure Hard Wheat Standard Middlings. Washburn Mills	O	17.94	15.00	–	4.00	**	2314
Pure Winter Wheat Middlings. Hunter Bros. Milling Co., St. Louis	O	19.82	16.00	–	4.00	**	2384
Vinco Middlings.	O	15.94	15.84	–	–	**	2317
Valley City Milling Co.,	O	15.63	16.84	–	4.00	**	2376
William Tell Winter Wheat Middlings.	O	17.75	14.50	–	4.00	**	2276
Ansted & Burke Co.,	O	17.50	14.50	–	4.00	**	2311
Springfield, Ohio.	O	17.50	14.50	–	3.50	**	2329
Winona Fancy Standard Middlings. Bay State Milling Co.	O	18.94	17.75	–	6.01	**	2313
WHEAT OFFALS, MIXED FEED.							
Acme Feed. Acme Evans Co., Indianapolis, Ind.	O	16.50	15.00	–	4.00	Fragments	2246
Blish's Bull's Eye Mixed Feed.	O	16.93	16.00	–	4.70	Fragments	2200
Blish Milling Co., Saymore, Ind.	O	16.75	17.20	–	4.90	Few	2271
Boston Mixed Feed.	O	17.25	16.00	–	4.50	Fragments	2224
Duluth Superior Milling Co.	O	15.88	16.00	–	4.50	Fragments	2289
Certified Extra Heavy Soft Wheat Mixed Feed. Hunter Robinson Wenz, St. Louis	O	15.75	15.00	–	4.00	Few	2415
Columbia Mixed Feed.	O	17.00	16.80	–	4.10	Few	2387
Coombs Milling Co., Mixed Feed. Wm. A. Coombs Milling Co., Coldwater, Mich.	O	15.75	15.00	–	3.00	Fragments	2241
Gem Soft Wheat Mill Run Mixed Feed. Allen Baker Co., St. Louis, Mo.	O	16.38	14.00	–	4.00	Fragments	2369
Gold Mine Mixed Feed. Sheffield King Co., Minneapolis	O	17.25	17.00	–	4.50	Fragments	2385

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—Continued.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Weed seeds. Found—percent.	Station number.
Gwinn's Mixed Feed.................. Gwinn Milling Co., Columbus, O.	D	17.00	16.35	–	5.40	Fragments	2202
Kent Mixed Feed...................... Williams Bros. Co., Kent, Ohio	O	16.07	12.00	–	2.00	Fragments	2227
Kent Mixed Feed, Winter Wheat... Williams Bros. Co., Kent, Ohio	O	16.32	12.00	–	2.00	Fragments	2288
King Feed..	O	16.94	15.00	–	4.00	Few	2215
R. P. Moore Milling Co.	O	17.75	15.00	–	4.00	Fragments	2403
N. M. Co's. Mixed Feed.............. N. M. Co., Noblesville, Ind.	O	16.88	15.00	–	4.00	None	2374
Occident Mixed Feed................	O	17.75	15.00	–	4.50	**	2201
Russell Miller Milling Co..........	O	17.82	15.00	–	4.50	Fragments	2205
							2245
Pillsbury's Fancy Mixed Feed....... Pillsbury Milling Co., Minneapolis,	O	17.50	16.00	–	4.50	Fragments	
Red Star Mill Run Mixed Feed...... Hannibal Milling Co., Hannibal, Mo.	O	16.75	14.00	–	4.00	Few	2340
Sleepy Eye Mixed Feed.............. Sleepy Eye Milling Co.	O	16.32	14.40	–	5.10	Few	2218
Snow Flake Mixed Feed.............. Lawrenceburg Roller Mills Co.	O	17.57	–	–	–	Fragments	2203
Stock's Monarch Wheat Feed....... F. W. Stock & Sons, Hillsdale, Mich.	O	17.44	–	–	–	Many	2244
Trojan Mixed Feed.................. Allen Wheeler Co.	O	16.57	15.00	–	4.00	Fragments	2207
Try Me Winter Mixed Feed.......... Spraks Milling Co.,	O	16.81	17.15	–	4.45	Few	2199
Wild Fire Mixed Feed............... Hunter Robinson Wenz Co., St. Louis.	O	16.32	15.00	–	4.00	None	2209
William Tell Mixed Feed............	O	16.38	14.50	–	3.50	Fragments	2273
Ansted & Burk Co., Springfield, Ohio.	O	17.50	14.50	–	3.50	None	2377
Winona Mixed Feed.................. Bay State Milling Co.	O	16.25	17.00	–	5.03	Fragments	2282
Winter Mixed Feed.................. Chapin & Co., Boston, Mass.	O	16.38	14.00	–	3.00	Fragments	2221
Wirthmore Wheat Feed.............. Chas. M. Cox Co., Boston, Mass	O	17.19	16.00	–	4.00	Fragments	2416

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—Coninued.

NAME OF FEED AND MANUFACTURER OR SHIPPER.	Source of sample.	PROTEIN. Found—percent.	PROTEIN. Guaranteed—percent.	FAT. Found—percent.	FAT. Guaranteed—percent.	WEED SEEDS. Found—percent.	Station number.
WHEAT OFFALS, BRAN.							
Anchor Brand. Kemper Mill and Elevator Co., Kansas City, Mo.	O	14.88	14.50	–	4.00	**	2347
Big Jo Bran. Wabash Roller Mill Co.	O	15.88	15.20	–	5.10	**	2398
Commander Bran. Commander Mill Co., Minneapolis	O	14.82	14.00	–	4.00	Few	2410
Washburn & Crosby Co.'s Coarse Wheat Bran	O	15.38	14.50	–	4.00	Few	2275
Hubbard Milling Co., Pure Flaky Bran. Hubbard Milling Co., Mankato, Minn.	O	16.44	13.20	–	4.80	Few	2372
Lucky Bran. Federal Milling Co., Lockport, N. Y.	O	16.82	14.00	–	4.00	Fragments	2405
Pure Wheat Jersey Bran. Geo. C. Christian, Minneapolis	O	15.63	13.00	–	4.00	Fragments	2375
Voight's Pure Winter Wheat Bran. Voight Milling Co., Grand Rapids, Mich.	O	15.50	–	–	–	Few	2339
Washburn Crosby Bran. Washburn Crosby Co	O	15.50	14.00	–	4.00	Many	2349
Washburn Crosby Co.'s Unadulterated Coarse Wheat Bran. Washburn Mills	O	16.38	14.00	–	4.50	Few	2268
Winter Wheat Bran. Wm. A. Coombs Milling Co., Coldwater, Mich.	O	14.38	–	–	3.00	Fragments	2341
Winter Wheat Bran. Crosby Roller Milling Co. Topeka, Kansas.	O	15.00	14.00	–	3.00	None	2890
ADULTERATED WHEAT OFFALS.							
Blue Grass Mixed Feed. A. Waller & Co., Henderson, Ky.	O	11.19	9.00	3.25	2.00	Fragments	2348
Dairy Winter Mixed Feed	O	12.75	11.00	3.28	3.00	Fragments	2242
Henry Jennings, Boston, Mass.	O	12.25	11.00	–	3.00	Fragments	2370
Jersey Mixed Feed. Indiana Milling Co.,	O	11.44	10.00	–	2.50	**	2392

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—Continued.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Weed seeds. Found—percent.	Station number.
MISCELLANEOUS COMPOUND FEEDS. Protein over 20 percent.							
Park & Pollard Co's	O	24.38	20.00	–	3.00	Few	2301
Dry Mash Feed	O	21.00	20.00	–	3.00	Few	2325
Park & Pollard Co.,	O	20.50	20.00	3.45	3.00	**	2337
Boston, Mass.	O	26.00	20.00	–	3 00	None	2994
Ubiko Union Grains	O	24.25	24.00	–	7.00	Few	2294
J. W. Biles Co., Cincinnati, O.	O	24.38	24.00	–	7.00	Few	2298
	O	24.00	24.00	–	7.00	Few	2328
Unicorn Dairy Ration	D	25.87	26.00	–	6.00	**	2171
Ajax Milling & Feed Co.,	D	25.75	26.00	–	6.00	**	2197
Milwaukee, Wis.	O	26.52	26.00	7.60	6.00	Fragments	2212
	O	27.43	26.00	5.58	6.00	Few	2300
Union Grains, Biles Ready Ration	O	24.93	24.00	7.80	7.00	Fragments	2220
J. W. Biles Co., Cincinnati, O.	D	24.12	24.00	–	7.00	**	2332
	D	25.50	24.00	–	7.00	**	2356
MISCELLANEOUS COMPOUND FEEDS. Protein 15–20 percent.							
Badger Dairy Feed	O	20.63	16.00	5.13	3.50	Few	2217
Chas. A. Krause Milling Co.,	O	15.13	16.00	6.46	3.50	Few	2400
Milwaukee, Wis.	D	14.94	16.00	–	3.50	**	2429
Eaco Winged Horse Mixed Feed	O	17.46	15.00	–	3.00	Fragments	2247
Everett Augenbaugh Co.,	O	16.32	15.00	5.97	3 00	Fragments	2278
Waseca, Minn.							
Gwinn's Dairy Feed	O	17.69	16.39	–	4.50	Few	2269
Gwinn Milling Co., Columbus, O.							
Husted Molasses Feed	O	18.07	18.00	5.23	4.00	Many	2345
Husted Milling Co.							
Quaker Dairy Molasses Feed	O	16.19	16.00	–	–	Few	2292
Quaker Oats Co., Chicago, Ill.	O	16.69	16.00	3.53	3.50	Few	2343
	D	16.44	16.00	–	3.50	**	2352
	D	16.94	16.00	–	3.50	**	2366
Scribner's Laying Mash	O	19.25	20.00	4.02	3.00	Fragments	2248
D. & C. E. Scribner,							
Brunswick, Me.							
Sucrene Dairy Feed	O	16.56	16.50	5.88	3.50	Many	2240
American Milling Co.,	O	16.38	16.50	–	3.50	Many	2413
Chicago, Ill.							
Sugarota Dairy Feed	D	15.63	16.00	–	3.00	**	2166
Northwest Mills Co.,	O	14.50	16.00	7.19	3.00	Few	2208
Winona, Ind.	O	14.38	18.00	5.07	4.50	**	2287
	O	15.41	18 00	4.95	4.50	**	2380
Sunshine Milk Feed	O	16.69	16.00	–	4.00	Fragments	2204
Hunter Bros. Co.							

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

ANALYSES OF SAMPLES OF FEEDING STUFFS—Concluded.

Name of Feed and Manufacturer or Shipper.	Source of sample.	Protein. Found—percent.	Protein. Guaranteed—percent.	Fat. Found—percent.	Fat. Guaranteed—percent.	Weed seeds. Found—percent.	Station number.
MISCELLANEOUS COMPOUND FEEDS. Protein 10-15 percent.							
Daisy Dairy Feed	O	14.63	14.00	2.24	3.00	Few	2243
Great Western Cereal Co., Chicago	O	14.13	14.00	–	3.00	Many	2281
Horse Feed Buffalo Cereal Co.	O	11.13	10.00	–	4.00	Few	2399
Schumachers Scratching Grains	O	11.46	10.50	3.45	3.50	Many	2291
Quaker Oats Co., Chicago, Ill.	O	10.63	10.50	–	3.50	Many	2351
	O	–	10.50	–	3.50	Many	2419
Schumacher Stock Feed	O	11.32	10.00	3.65	4.00	Few	2219
Quaker Oats Co., Chicago, Ill.	O	10.69	10.00	–	4.00	Few	2239
	O	10.50	10.00	–	4.00	Fragments	2286
	O	10.32	10.00	–	3.25	Few	2290
	D	10.38	10.00	–	3.25	**	2354
	D	11.63	10.00	–	8.25	**	2365
MISCELLANEOUS COMPOUND FEEDS. Protein under 10 percent.							
Brooks Fancy Corn & Oat Stock Feed A. H. McLeod Milling Co., St. Johnsbury, Vt.	O	7.75	7.63	–	2.97	None	2412
Empire Feed. Corn, Hominy, Oat Hulls Empire Mills, Orlean, N. Y.	O	6.75	7.50	–	3.00	Few	2388
Empire Feed for Stock Empire Mills, Orlean, N. Y.	O	8.56	7.63	–	3.97	None	2417
Haskell's Stock Feed	O	8.63	8.00	7.06	4.00	Fragments	2342
W. H. Haskell & Co., Toledo, O.	O	8.82	8.00	–	4.00	Few	2401
	O	8.94	8.00	–	4.00	None	2407
Husted Stock Feed Husted Milling Co., Buffalo, N. Y.	O	8.75	9.00	5.88	4.00	Few	2285
Matchless Stock Feed	O	8.13	7.60	3.92	3.90	None	2280
Star Feed	D	8.19	7.00	–	5.50	**	2189
Toledo Elevator Co., Toledo, O.	O	10.13	7.00	6.72	5.50	**	2315
Toledo Stock Feed Toledo Elevator Co., Toledo, O.	D	10.38	9.00	–	5.00	**	2188
Victor Feed Quaker Oats Co., Chicago, Ill.	O	8.44	7.50	–	3.00	Many	2383
Xtragood Stock Feed Griswold & MacKinnon	O	7.00	7.63	3.70	2.97	Few	2409
MISCELLANEOUS.							
Corn Bran Saco Grain & Milling Co., Saco, Me	M	8.00	–	–	–	**	2235

** Not tested for weeds.

C, from the feeder; D, from the dealer; M, from the manufacturer; and O, the inspector's sample.

Sta. No.	Name of feed	Whole Weed Seeds Present.
2271	Blish's Bulls Eye Mixed Feed	Few dock.
2415	Certified Extra Heavy Soft Wheat Mixed Feed	Few lady's thumb
2387	Columbia Mixed Feed	Few yellow foxtail, wild buckwheat and false flax
2215	King Feed	Few wild buckwheat and green foxtail
2340	Red Star Mill Run Mixed Feed	Few wild buckwheat
2218	Sleepy Eye Mixed Feed	Few yellow foxtail
2244	Stock's Monarch Wheat Feed.	Wild buckwheat, mustard, yellow, fox tail, ragweed, pigweed and corn cockle
2199	Try Me Winter Mixed Feed	Few corn cockle and wild buckwheat
2410	Commander Bran	Few false flax
2275	Washburn Crosby Co's Coarse Wheat Bran	Few yellow foxtail
2372	Hubbard Milling Co. Pure Flaky Bran	Few mustard and wild buckwheat
2339	Voights' Pure Winter Wheat Bran	Wild buckwheat, corn cockle and mustard
2349	Washburn Crosby Bran	Many pigweed, few yellow foxtail and wild buckwheat
2268	Washburn Crosby Co's Unadulterated Coarse Wheat Bran	Few pigweed, yellow foxtail and night flowering catchfly
2301	Park & Pollard Co's Dry Mash Feed	Few wild buckwheat
2325	" " " " " " "	Few mustard, corn cockle, lady's thumb and yellow foxtail
2294	Ubiko Union Grains	Few wild buckwheat
2298	" " "	Few wild buckwheat and mustard
2328	" " "	Few wild buckwheat and mustard
2300	Unicorn Dairy Ration	Few wild buckwheat and mustard
2217	Badger Dairy Feed	Few green foxtail, barnyard grass, wild buckwheat
2400	" " "	Few green foxtail, yellow foxtail, mustard
2269	Gwinn's Dairy Feed	Few lady's thumb
2345	Husted Molasses Feed	A number of green foxtail, mustard, lady's thumb, few pigweed and chicory
2292	Quaker Dairy Molasses Feed	Few lady's thumb, pigweed, yellow fox tail and green foxtail
2343	" " " "	Few yellow foxtail, green foxtail and pigweed
2240	Sucrene Dairy Feed	A number of yellow foxtail, wild buckwheat, pigweed, lady's thumb, green foxtail and mustard
2413	" " "	Large number yellow foxtail, green foxtail pigweed, lady's thumb, persicaria, wild buck wheat and mustard.
2208	Sugarota Dairy Feed	Green foxtail, lady's thumb, wild buckwheat and mustard.
2243	Daisy Dairy Feed	Few foxtail. Others not identified.
2281	" " "	A number of lady's thumb, mustard and wild buckwheat.

Sta. No.	Name of Feed.	Whole Weed Seeds Present.
2399	Horse Feed, Buffalo Cereal Co.	Few pigweed and mustard,
2291	Schumacher Scratching Grains..........	Number of corn cockle, some yellow foxtail, mustard, persicaria, low senna.
2351	" " "	Number of corn cockle, few mustard, yellow foxtail and low senna
2419	" " "	Large number of corn cockle.
2219	Schumacher Stock Feed..................	Few pigweed.
2239	" " "	Few pigweed.
2290	" " "	Few pigweed.
2388	Empire Feed............................	Few pigweed.
2401	Haskell's Stock Feed.....................	Few pigweed.
2285	Husted Stock Feed.......................	Few pigweed.
2383	Victor Feed..............................	Number of pigweed.
2409	Xtragood Stock Feed.....................	Few pigweed.

RESULTS OF FEEDING STUFFS INSPECTION.

It is gratifying to be able to say that the general feeding stuffs situation in Maine has decidedly improved during the last two years. Analyses show the feeds to run for the most part well above the guarantees, and weed seeds seem to be much less abundant. The plan of submitting frequent samples for analysis now pursued by most dealers is in great measure responsible for the improvement and the Station advises that this be continued.

The *cottonseed meals* ran for the most part well over the guarantees and, although occasional samples dropped one or two per cent and one or two nearly four per cent under the guarantee, the low grade meals were not nearly as abundant as they were a few years ago. It sometimes happens that a dealer sends a sample which is found to run under the guarantee and a second sample shows considerable improvement. Apparently the two samples came from the same lot and were both carefully drawn. Such variations are usually accounted for by the fact that the shipper obtained the meal from two or more different runs, often from different factories. Attention is called to the discussion of cottonseed meals in Official Inspections 10.

A few samples of *linseed oil meals* were all above the guarantees and it is to be regretted that this kind of feed is not more commonly used.

The report on *gluten feeds* shows marked improvement. It was seldom that a sample fell below its guaranty during the past year. While artificial color is still used, that fact is usually found to be stated on the package and the color used, as far as determined, was one of the allowed dyes. However, the practice of coloring feeds is to be discouraged, since it certainly adds nothing to the value of the product and it might be found, if a test case were made, that at times it concealed inferiority and thus violated the State and National food and drug laws. As far as our observation goes, the acidity of gluten feeds runs lower than a few years ago.

Dried distillers' grains for the most part conform very well to their guarantees. It is a more difficult matter to sample these goods than most kinds of feed and dealers should take particular care when sending samples for analysis. It seems a mistake to call some kinds of distillers' grains gluten feed, as is done in some cases, although they somewhat resemble the latter in composition.

The *wheat offals,* middlings, mixed feeds, and brans are not required by the law to carry a guaranty, but most of the manufacturers have adopted the plan of guaranteeing protein or both protein and fat, and the plan is a good one. Almost every sample of this class of goods ran above its guaranty. Some fragments of weed seeds were found in many of the wheat offals and in a few cases whole seeds were present, but in only one case were they in sufficient numbers to give the impression of a carelessly or fraudulently prepared feed.

The *adulterated wheat offals* contained ground corn cobs and as they, as far as we learned, all carried tags stating their composition. It is the fault of the feeder if he buys one of these brands containing only about two-thirds the protein of a good mixed feed because it can be purchased for 5 or 10 cents less per hundred.

The *miscellaneous feeds* of various kinds carry guarantees ranging all the way from 7.50 to 26.00 per cent protein, the lower grades usually having the highest sounding names. Some of these feeds are legitimate mixtures no doubt worth the price

asked for them, while others are made up solely with the object of getting rid of screenings, sweepings, and the refuse from cereal breakfast food mills. Some of them contain an excess of hulls and chaff and some contain large quantities of ground-up weed seeds.

The byproducts of breakfast food mills, oat hulls, and such materials have a feeding value and the feeder of the future will no doubt use them in their proper place. They should not be forced upon him under high-sounding names, ground into a fine powder and further disguised with cheap molasses. The attention of the public is continually called to this important point by the bulletins of the various experiment stations and still the mixtures of ground corn cobs, oat hulls, and weed seeds seem to find a ready sale.

CONDIMENTAL REMEDIES.

Condimental foods are remedies and not food, and come under the requirements of the Food and Drug Law. They are, so far as our observation goes, sold lawfully. From time to time the Experiment Station has called the attention of feeders to the uselessness of this class of remedies. The following or similar statements have been published every little while and are as true today as when they were first written.

Facts to be Remembered.

The mixture of ingredients contained in the ordinary foods comprises all that are known either to practice or science as useful to animal life.

The ordinary cattle foods supply animal nutrition in the most useful and economical forms.

Condimental foods are absurd as medicines. If an animal is well no medicine is needed, if ill, remedies adapted to the case should be administered.

It is to be hoped that the manufacturers of this class of materials flourish not on the ignorance of farmers but on that lingering remnant of old times, which made saltpeter and sulphur the universal cure-all for horses and cattle.

The farmer can manufacture his own "condimental" food at a fraction of the usual cost, by mixing a small amount of such common substances as salt, sulphur, saltpeter, fenugreek, caraway, etc., with the daily ration.

July, 1910

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

Analysts

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Official Inspections.

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NOTICE — CURRANTS AND RAISINS.

Attention is called to the discussion, in Official Inspections 22, of currants and raisins. Four points should again be brought to the notice of the trade and the public.

Out of 82 packages only 3 weighed a pound, net.

Many of the packages, especially the currants, contained an inexcusable amount of dirt.

A smaller number contained live worms or the excreta of insects.

Some of the brands were labeled with statements which were either grossly exaggerated or entirely untrue.

As most of the shippers and dealers with whom we have corresponded concerning this matter express themselves as willing to remove objectionable statements from packages and, as far as possible, correct the faults which we have found, and as this is the first time that we have taken up this subject, it was thought best to make no prosecutions in the present cases. Before another extended investigation of these goods is made sufficient time will be allowed for the packers and shippers to correct the faults to which attention has been called.

PREPARED MUSTARD.

According to the food standards and definitions adopted for Maine, prepared mustard is defined as follows: "Prepared mustard, German mustard, French mustard, mustard paste, is a paste composed of a mixture of ground mustard seed or mustard flour with salt, spices and vinegar, and, calculated free from water, fat and salt, contains not more than twenty-four (24) percent. of carbohydrates calculated as starch, determined according to the official methods, not more than twelve (12) percent. of crude fiber nor less than thirty-five (35) percent. of protein, derived solely from the materials named."

Five out of the six samples examined contained turmeric. In those prepared by Libby, McNeil & Libby of Chicago, the amount of turmeric present was so slight that it is assumed to be accidental.

According to the decision of the United States Board of Food and Drug Inspection the addition of turmeric to mixed mustard without declaring its presence constitutes an adulteration. Consequently No. 8642, No. 8644 and No. 8641 are misbranded and adulterated under the definitions of the law. No. 8642 is further adulterated in that it contains cereal. In the case of 8642, the company acknowledge the presence of both the cereal and the turmeric and are correcting their labels. The case is being further investigated under the law.

Some manufacturers justify the use of turmeric in such cases as the above on the ground that it is a spice, and that, having a distinctive odor and flavor, it forms one of the principal ingredients of certain mixtures such as curry powder. Some authorities seem to favor this view and therefore we have not as yet made any prosecutions under the State law for such seeming violations. However, when turmeric is used in such products in connection with such material as starch there would seem to be no doubt but that the color produced by the turmeric conceals inferiority and is, in such a case, unlawful.

In case of No. 8641, the manufacturers claim that they did not put any turmeric into the goods and also claim that in the samples which they obtained at the same place where the Station samples were bought, they found no turmeric present. Samples in the possession of the Station were re-examined and the presence of turmeric was found without doubt.

Table showing the analyses of prepared mustards purchased in Portland in October, 1909. The samples are arranged alphabetically by the countries or states in which they were manufactured.

Sta. No.	State, Town, Maker and Brand.	Price cents.	Size of jar ozs..	Dry matter %.	Remarks.
8643	France Bordeaux. "Cresca Mustard Pinard Brand."	30	7.6	33.2	Passed.
8640	Illinois, Chicago. Libby, McNeill & Libby. "Libby's Prepared Mustard. Serial No. 288."	10	6.0	20.0	A trace of turmeric present. Passed.
8642	Mass., Boston. S. S. Pierce Co. "Mixed English Mustard."	25	5.1	33.3	Adulterated with cereal and turmeric. Misbranded.
8650	Michigan, Detroit. Williams Bros. Co. "Williams Prepared Mustard." Turmeric declared on label	5	4.4	19.9	Turmeric present, but declared. Passed.
8644	N. Y. Chas. Gulden. "Gulden's Prepared Mustard."	10	7.8	22.7	Turmeric present not declared, unlawful.
8641	N. Y. Chas Gulden. "Dusseldorfer Prepared Mustard. Serial No. 2291."	25	8.4	23.0	Turmeric present. Not declared. Unlawful.

CREAM OF TARTAR.

In March the inspector purchased bulk cream of tartar in Portland and Saco, calling in each case for a quarter of a pound. Each package was carefully weighed upon its receipt at the Station before the moisture could change, and was afterwards analyzed. No. 8820 was sold as a compound and it was marked "compound" on the package. Nos. 8823 and 8825 were investigated and it was found that these samples were purchased in bakeries, that the compounds had been purchased by the proprietors as such, and were for use on the premises, that it was not kept for sale but had been sold occasionally to accommodate a customer. These facts were well established and the cases were dropped. In No. 8829, where short weight was given, the case was dropped after a warning. Nos. 8159 and 8284 were sent in by correspondents and the complete analysis was not made.

*Table showing names of dealers from whom cream of tartar was purchased in bulk in March, 1910.**

Station number.	Dealer and Brand.
8159	C. W. Hopkins, Milbridge. Stickney & Poor's Pure Cream Tartar.*
8284	J. E. Goold & Co., Portland. Chas. Pfizer & Co., New York,
8819	Sullivan & Osgood, Portland. Bulk goods.
8820	Central Cash Market, Portland. Bulk goods.
8821	Globe Store Co., Portland. Bulk goods.
8822	E. F. Hillman, Portland. Bulk goods.
8823	S. Jensen (Baker), Portland. Bulk goods.
8824	P. W. Reed, Portland. Bulk goods.
8825	MacLeod & MacMillan (Bakery), Portland. Bulk goods.
8826	Brown & Bishop, Portland. Bulk goods.
8827	Portland Cash Grocery & Provision Store, Portland. Bulk goods.
8828	W. L. Wilson & Co., Portland. Bulk goods.
8829	J. Q. Sawyer, Saco. Bulk goods.
8830	Emery's Cash Grocery, Saco. Bulk goods.

*Table showing results of analyses of cream of tartar purchased in bulk in March, 1910.**

Station number.	Starch.	Aluminum.	Sulphates.	Calcium.	Phosphates.	Cream of tartar by titration—percent.	Net weight—ounces.	Purchase price—cents.
8159	None	....	None	....	None	....	....	....
8284	....	....	None	Trace	None	99.0	....	....
8819	None	None	None	Trace	Trace	98.5	4.4	9
8820	Present	Present	Present	Present	Present	Trace	4.2	8
8821	None	None	None	Trace	Trace	98.3	4.1	9
8822	None	None	None	Trace	Trace	97.9	4.5	10
8823	Present	Present	Present	Present	Present	Trace	3.8	7
8824	None	None	None	Trace	Trace	99.1	4.7	8
8825	Present	Present	Present	Present	Present	Trace	4.3	5
8826	None	None	None	Trace	Trace	98.9	4.6	10
8827	None	None	None	Trace	None	99.1	4.0	12
8828	None	None	None	Trace	Trace	98.9	4.3	10
8829	None	None	None	Trace	Trace	99.1	3.6	6
8830	None	None	None	Trace	Trace	97.7	4.0	9

* Samples 8159 and 8284 were package goods from correspondents.

CANNED VEGETABLES.

A few packages of beans, peas and tomatoes were purchased in Portland in Octobr, 1909. The results of the examination are given in the table which follows.

While the goods were not all strictly lawful, they were passed without hearings being appointed. The deviations which were due to mislabeling were not serious. Probably as the requirements of the law become more clearly understood the labeling will be corrected. For instance the beans were called "stringless beans" when in fact they were not stringless. One lot of peas was labeled "Champion of England Peas" which were not wrinkled. The Champion of England is a wrinkled pea. Another lot was called a "wrinkled style of pea" but the peas were not wrinkled.

Table showing results of examination of canned vegetables purchased in Portland, October, 1909.

Sta. No.	State, Packer, Brand.	Price cents.	Weight. Total ozs.	Weight. Vegetable ozs.	Weight. Liquid ozs.	Remarks.
	BEANS					
8637	Maryland, Baltimore. The Booth Packing Co. "Booth's Green Oval Brand Stringless Beans"	12	18.9	8.3	10.6	No coloring matter or preservatives found. Beans were not stringless. Passed.
	PEAS					
8636	Michigan, Hartford. Wm. M. Traver & Co. "Our Boy Brand Sweet Early June Peas."	10	21.7	14.9	6.8	No coloring matter or preservatives found. Peas uneven as to age. A few had sprouted. Passed.
8645	New York, Rochester. Curtis Bros. Co. "Champion of England Peas."	12	20.8	12.7	8.1	No coloring matter or preservatives found. Apparently young peas. Not wrinkled. Passed.
8646	New York, Rochester. Curtis Bros. Co. "Early June Peas"	18	20.7	13.3	7.4	No coloring matter or preservatives found. Passed.
8635	Wisconsin, Green Bay. Wm. Larsen Canning Co. "Esdale Brand Sweet Wrinkled Style Peas"	17	19.9	12.7	7.2	No coloring matter or preservatives found. Apparently old peas. Not wrinkled. Passed.
8649	Name of manufacturer and place not given. "Sweet Garden Peas"	15	20.6	13.2	7.4	No coloring matter or preservatives found. Contains some old peas. Passed.
	TOMATOES					
8647	Maryland, Baltimore. W. W. Berger & Co. "Cottage Tomatoes"	10	33.6	–	–	No coloring matter or preservatives found. Good condition. Passed.
8634	Name and place of mfg. not given. "The Imperial Tomato"	15	36.5	–	–	No coloring matter or preservatives found. Good condition. Passed.
8648	Name and place of mfg. not given. "Dogwood Brand Tomatoes"	–	33.4	–	–	No coloring matter or preservatives. Unripe pieces present. Also skins. Not first quality. Passed.

SALT.

The following table gives the results of the examination of eight different brands of table salt purchased by the inspector and one sample sent by a correspondent.

Standard.—Table salt, dairy salt, is fine grained crystalline salt containing on a water-free basis, not more than one and four-tenths (1.4) percent. of calcium sulphate ($CaSO_4$) nor more than five-tenths (0.5) percent. of calcium and magnesium chlorides ($CaCl_2$ and $MgCl_2$), nor more than one-tenth (0.1) percent. of matters insoluble in water.

The determinations made were water, sulphuric acid, calcium, magnesium, and matters insoluble in cold, distilled water. Tests for starch and carbonates were made in all cases. Carbonates were found only in the cases of the two compounds and starch was not found at all. In the calculation of results the sulphuric acid was assumed to be in combination with calcium as calcium sulphate, and any excess of calcium was calculated to the chloride. Magnesium was assumed to be present as chloride. In the cases of the compounds containing carbonates carbon dioxide was determined with Schlötter's apparatus and this was calculated with either calcium or magnesium as either was found to be present.

Attention is called to some of the exaggerated statements which appear in connection with some brands of salt. For example: "Caution—Use one-third less of this salt than of other kinds, because the perfect purity of this brand renders it so much stronger"; and "an ounce of this salt is 'saltier' than an ounce of any other salt"; and "this salt is the only table salt free of dangerous impurities and adulterants." Such claims are not borne out by facts, and the manufacturers and packers, not only of salt but of all food products, should realize that the public is fast coming to believe that such unreasonable, exaggerated claims as the above are likely to appear in connection with the lowest grades of goods.

The figures given in the table are the results as found. Calculating these to the water-free basis makes no difference to the second decimal place except for number 8808, where the percentage of matters insoluble in water is 1.06 per cent, calcium sulphate 1.27 per cent, and magnesium carbonate 1.00 per cent on the water-free basis.

Table showing brand, maker and dealer from whom salt was purchased in March, 1910.

Station number.	Brand.	Dealer and Maker or Packer.
8814	Diamond Crystal..	Manhattan Market, Portland. Diamond Crystal Salt Co., St. Clair, Mich.
8811	Hatchet	John W. Deering & Son, Portland. Twitchell-Champlin Co., Portland.
8815	Imperial	E. A. Whitney, Portland. D. W. True & Co., Portland.
8808	Ivory..............	F. W. Brown, Bath. Worcester Salt Co., New York.
8809	Peerless	G. H. Cloyes, Portland. Lord Bros., Portland.
8813	Portland	Geo. W. Parker, Portland. Lord Bros., Portland.
8833	Shaker	G. H. Cloyes, Portland. Diamond Crystal Salt Co., St. Clair, Mich.
8812	Worcester.........	D. W. Patterson, Portland. Worcester Salt Co., New York.
8723	Worcester.........	James P. Baxter, Portland. Worcester Salt Co., New York.

Table showing results of analyses of salt purchased in March, 1910.

Station number.	Net weight—pounds.	Price per package—cents.	Price per pound—cents.	Water—percent.	Matter insoluble in water—percent.	Calcium sulphate—percent.	Calcium chloride—percent.	Magnesium chloride—percent.	Sodium chloride—percent.
8814	3.06	10	3.2	0.00	0.00	0.23	0.00	0.06	99.71
8811	2.56	5	1.9	0.20	0.00	1.31	0.27	0.04	98.18
8815	2.68	5	1.8	0.27	0.15	1.23	0.29	0.04	98.02
8808	2.06	10	4.8	0.55	1.05*	1.26	0.26	0.26	96.62
8809	2.43	5	2.1	0.40	0.00	1.14	0.21	0.13	98.12
8813	3.75	10	2.6	0.30	0.10	1.21	0.11	0.06	98.22
8833	2.18	10	4.5	0.15	1.60†	0.12	0.36	0.13	97.64
8812	2.75	5	1.8	0.35	0.10	0.82	0.07	0.13	98.53
8723	....	....	... .	....	....	1.18	....	Trace..	....

*0.99 percent magnesium carbonate. Stated on label.
† 1.60 percent calcium carbonate. Stated on label.

Table showing brand, maker and dealer from whom canned milk was purchased in Spring of 1910.

Station number.	Brand.	Dealer and Manufacturer.
	Condensed Milk (Sweetened).	
8805	Arrow	Cash Market Co., Bath. Wisconsin Condensed Milk Co.
8834	Challenge	C. A. Mercier. Portland. Borden's Condensed Milk Co.
8859	Defiance	O. P. Gerry, Brownville. Borden's Condensed Milk Co.
8862	Defiance	M. G. Brackett, Milo. Borden's Condensed Milk Co.
8858	Eagle	R. H. McDonald, Presque Isle Borden's Condensed Milk Co.
8802	Moosehead	H. E. Houdlett, Richmond. Borden's Condensed Milk Co.
8797	Rubric	Alton L. Carr, Sangerville. Emery Food Co.
8861	Rubric	W. C. Wells, Brownville. Emery Food Co.
8807	Ruby	W. E. Chase, Bath. Vermont Condensed Milk Co.
8832	Summit	S. K. Ames, Portland. Boston Dairy Co.
	Evaporated Milk (Unsweetened).	
8860	Libby's	W. G. Wells, Brownville. Libby, McNeill & Libby.
8798	Peerless	Sanders Bros. & Co., Sangerville. Borden's Condensed Milk Co.
8857	Silver Cow	R. M. Barker, Presque Isle. St. Charles Condensing Co.
8810	St. Charles	John W. Deering & Son, Portland. St. Charles Condensing Co.
8856	St. Charles	R. M. Barker, Presque Isle. St. Charles Condensing Co.
8806	Van Camp's	Rodney McDonald, Bath. The Van Camp Packing Co.

Table showing results of analyses of canned milk purchased in the Spring of 1910.

Station number.	Net weight—ounces.	Purchase price—cents.	Ash—percent.	Total solids—percent.	Fat. Gottlieb—percent.	Fat. Double extraction—percent.	Protein—percent.	Lactose—percent.	Sucrose—percent.
	Condensed Milk (Sweetened).								
8805	12.7	10	1.72	69.77	10.15	10.37	8.36	12.12	37.31
8834	12.8	10	1.66	71.86	8.78	8.71	7.40	11.69	42.33
8859	12.7	10	1.75	74.16	8.85	....	7.45	12.50	43.61
8862	12.9	10	1.74	73.58	8.70	....	7.46	12.20	43.48
8858	15.8	18	1.74	72.28	8.52	....	7.40	11.94	42.71
8802	12.9	10	1.73	73.02	8.45	8.51	7.80	12.31	42.98
8797	11.1	10	1.73	73.58	9.11	9.09	7.98	13.50	41.30
8861	11.1	10	1.75	74.60	9.39	....	8.13	13.36	41.97
8807	13.1	10	1.70	70.92	9.17	9.15	7.82	10.82	41.42
8832	13.6	11	1.87	76.66	9.64	9.30	9.25	12.42	43.48
	Evaporated Milk (Unsweetened).								
8860	12.2	10	1.60	26.84	8.13	....	7.40	9.48	....
8798	12.3	10	1.58	26.97	7.69	7.69	6.81	10.42	....
8857	16.5	10	1.60	27.76	8.43	....	7.15	10.63	....
8810	6.1	5	1.64	27.74	8.00	7.90	7.27	10.28	....
8856	16.7	10	1.64	28.72	8.34	....	7.34	10.42	....
8806	5.9	5	1.54	27.32	8.14	8.18	6.93	9.84	....

CONDENSED AND EVAPORATED MILK.

The sale of this class of goods is very extensive in Maine and the leading brands have been collected and analyzed with the results shown in the followng table. The terms "condensed" and "evaporated" are used in this state to mean sweetened and unsweetened respectively, and the standards require each to contains twenty-eight (28) percent. of milk solids of which not less than twenty-seven and five-tenths (27.5) percent. is milk fat.

Two of the evaporated milks ran about one percent. low on solids, although the fat was up to standard. These cases are being investigated. Only 3 of the brands were guaranteed as to weight and one of these, No. 8806, guaranteed to contain 6 ounces, net, ran a trifle under. The difference, however, was so slight that no account was made of it.

In the case of No. 8860, besides being below standard in milk solids, the can was not full and in consequence the contents was badly churned. This is a grave fault in a can of condensed or evaporated milk, as often times it is taken on long journeys, and the cans should be full enough to insure against churning.

From the standpoint of the consumer, the most interesting figures are those giving the net weight. The price paid for most of the cans was ten cents each. The average net weight of the sweetened milk purchased for that price was 12.4 ounces, or 1.24 cents per ounce. Using this as a basis, it will be seen that in purchasing Numbers 8797 and 8861 only nine cents worth of milk was received, whereas in Number 8807 there was ten and three-quarters cents worth. Number 8832, costing eleven cents, contained eleven cents worth of milk, Number 8858, costing eighteen cents, contained not quite thirteen cents worth. The unsweetened brands varied much more than the others, two of the brands sold for ten cents, containing over four ounces more than the two others sold for the same price. The two five-cent cans contained about half the weight found in the ten-cent size. In the cases of those brands which were lowest in net weight according to the price paid, the analysis did not indicate that the lack in quantity was made up by better quality.

DIRT AND FLIES.

Attention should be called to the question of dirt, dust, and flies in their relation to foods and the public health. It is a common thing to see sidewalk displays of fruits, berries, vegetables, meats, fish, etc., entirely unprotected from the clouds of dust blowing up and down the streets, but the dust, however germ laden it may be, is innocence itself in comparison to the flies that come directly from the stable, the hog pen, or the open closet and swarm over the food thus exposed for sale.

The common house fly, now known as the typhoid fly, breeds chiefly in fresh horse manure, and shows a decided preference for that which is wet and sloppy. It is also known to breed in human excrement, barn yard refuse, and other filth. The eggs hatch within 24 hours after egg laying, the maggots usually attaining full growth within a week, when they transform to pupæ remaining in this stage 3 to 7 days, and then emerge as full grown flies.

The adult flies feed greedily upon all kinds of filth and offensive offal, attack sores on all kinds of animals, swarm around the sputum and excreta of persons afflicted with loathsome and dangerous diseases, and then, whenever a chance offers, crawl eagerly over food, oftentimes leaving behind a trail of sickness and death. These are facts demonstrated beyond dispute.

In order to avoid such contamination the conditions surrounding all places where food is prepared or dispensed should be kept as clean as it is possible to make them.

Experiments have shown that flies usually will not lay eggs in dark places, neither will maggots develop if the material in which they are found becomes too dry, hence if the manure be drawn out and spread at frequent intervals in accordance with best agricultural practice, or stored in dark or fly proof cellars the development will be prevented. The relatively cheap cement underpinning makes it comparatively easy to construct dark cellars, places where manure and other fly-breeding material can be kept without producing swarms of flies.

No open closets, open garbage cans, or other avoidable breeding places for flies should be allowed near.

All doors or windows or other openings should be effectually screened.

All food products exposed for sale that are not afterwards cooked before being eaten should be protected from dust and flies. Meat carried by the itinerant meat-vender, and exposed in the open, attracts not only the germ laden house fly but blow-flies as well, which deposit their living young upon the food. If the meat be thoroughly cooked afterwards the maggots in themselves are not dangerous to health, though their presence in the food is anything but inviting.

The distribution of unprotected bread and pastry from the open shelves of carts driven through the dusty streets, the handling of these products by the driver who has handled the dirty, perspiring horse and the dirty, greasy harness, is a practice which could be easily improved by having all such material wrapped in paper before leaving the bakery.

The proprietors of places where food is either prepared or dispensed should without question see that the above conditions are maintained.

Each customer should insist that the dealer from whom food supplies are purchased maintain the above sanitary conditions.

OYSTERS.

In Official Inspections 15, page 152, the following standards for oysters were published:

Opened oysters sold in bulk should not contain ice or added water; nor more than 17 per cent by weight of free liquid; nor less than 10 per cent by weight of total dry solids.

This standard does not apply to oysters sold in the shell nor to oysters opened at time of sale.

Other states have since adopted the same standards, and the National Board of Food and Drug Inspection, in Decision 110, which became operative May 1, 1910, has forbidden the sale or shipment in interstate commerce of oysters to which water has been added either directly or in the form of melted ice. It should be borne in mind by all dealers, shippers, and transportation companies that these regulations should be strictly followed.

September, 1910

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director

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Official Inspections.

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FOOD AND DRUG REGULATIONS.

Official Inspections 14, published in September, 1910, contains the text of the Maine Food and Drug Law and the standards and regulations adopted to that date. The following additional standards and regulations are fixed and adopted by the Director of the Maine Agricultural Experiment Station as provided by section 5 of the law.

M. F. D. R. 21.

Shellfish.

A standard for oysters was published in Official Inspections 15, October, 1909, and Food Inspection Decisions 110 and 121, regulating the interstate sale and shipment of shellfish, were published in October, 1909, and June, 1910. The following governs the sale of oysters and other shellfish in Maine:

It is unlawful to ship or to sell oysters or other shellfish taken from insanitary or polluted beds. The pollution of oysters with sewage can readily be detected by bacteriological examination and such polluted oysters or other shellfish are adulterated under Section 3 of the Maine Food and Drug Law, in that they contain an added "poisonous or other added deleterious ingredient which may render such articles injurious to health." Such articles are likewise adulterated under Section 3, in the case of foods, be-

cause they consist "in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance."

It is unlawful to ship or to sell oysters or other shellfish which have become polluted because of packing under insanitary conditions or being placed in unclean receptacles. In order to prevent pollution during the packing or shipment of oysters, it is necessary to give proper attention to the sanitary condition of the establishment in which they are packed and to use only receptacles which have been thoroughly cleansed as soon as emptied. In order to prevent the possibility of contamination, it is desirable that such containers be sterilized before using.

It is unlawful to ship or to sell oysters or other shellfish which have been subjected to "floating" or "drinking" in brackish water, or water containing less salt than that in which oysters will grow to maturity. Such food is adulterated under Section 3 of the law because a substance "has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength." There can be no objection to "drinking" shellfish in unpolluted water of the salt content in which oysters will grow to maturity. Attention is called, however, to the dangers resulting from "drinking" shellfish near polluted fresh water streams and near other sources of pollution.

It is unlawful to ship or to sell shucked oysters to which water has been added, either directly or in the form of melted ice. Such food is adulterated under Section 3 of the act because a "substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength," and also because a "substance has been substituted wholly or in part for the article."

The packing of shellfish with ice in contact may lead to the absorption by the oyster of a portion of the water formed by the melting ice, thus leading to the adulteration of the oysters with water.

STANDARD FOR OYSTERS.

The following is the standard adopted for opened oysters in Maine:

Opened oysters sold in bulk shall not contain ice or added water; nor more than 17 per cent by weight of free liquid; nor less than 10 per cent by weight of total dry solids.

This standard does not apply to oysters sold in the shell nor to oysters opened at time of sale.

M. F. D. R. 22.

Cold Storage and Preserved Eggs.

The following governing the sale of eggs in Maine was first published in Official Inspections 16, November, 1909.

The National Government has successfully maintained cases against eggs, and people who have offered eggs for sale, that were in an unfit condition for food, as well as stored eggs that have been sold for fresh eggs. Attention is called to the fact that only freshly lain eggs can be lawfully sold as eggs in Maine without being labeled to show exactly what they are. Cold storage eggs or eggs that have been preserved in any way when offered for sale must be labeled in accord with fact and every package delivered to the consumer containing stored eggs must be labeled to show exactly what they are. Eggs that have begun to decompose cannot be lawfully sold in Maine under any conditions whatever.

M. F. D. R. 23.

Compressed Yeast.

The following regulating the sale of yeast in Maine was published in Official Inspections 21, March, 1910, and is in force until further notice.

THE LABELING OF YEAST.

The term "compressed yeast," without qualification, means distillers' yeast without admixture of starch.

If starch and distillers' yeast be mixed and compressed, such product is misbranded if labeled or sold simply under the name "compressed yeast." Such a mixture or compound should be labeled "compressed yeast and starch."

It is unlawful to sell decomposed yeast under any label.

THE SALE OF COMPRESSED YEAST IN MAINE.

The sale of compressed yeast in Maine must be made in conformity to the above requirements. It will not be enough that the goods be sold from packages properly labeled, but the yeast cake itself, if it contains starch or other foreign mate-

rials, must bear a label stating the exact facts. It will be lawful to sell without labeling and under the name "compressed yeast" yeast to which nothing has been added. All other yeasts which imitate compressed yeast, as above defined, must be correctly labeled when they are given to the consumer.

M. F. D. R. 24.

Dressed Poultry.

Under Section 3 of the Maine Food and Drug Law a food is adulterated "if it consists in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance, or any portion of an animal unfit for food, whether manufactured or not." This, of course, prohibits the sale of undrawn poultry. Quite extended investigations have shown, however, that poultry killed, while fasting, by bleeding through the mouth and without being drawn, keeps as well or perhaps even better in cold storage, than thoroughly drawn poultry. There is, however, no question but that partly drawn poultry is a menace to public health and should not be tolerated.

The so-called "wire-drawn" is probably the least objectionable of the many ways in which poultry is partly drawn. Even this, however, is dangerous, as it frequently happens that only part of the intestine is removed and more or less of the intestinal contents get into the body cavity. Even at the best, the opening into the gizzard remains open and portions of the gizzard contents charged with bacteria may find their way into the body cavity with the result that fermentation and decay speedily set in.

Until further notice the following regulation will govern the executive in the enforcement of the Maine Food and Drug Law in regard to the sale of poultry after January 1, 1911.

No prosecution will be made for the sale of undrawn poultry, provided (a) the bird was killed while fasting as indicated by the absence of food from the crop; (b) was properly bled; (c) the head is left upon the carcass; and (d) there are no openings into the body other than the natural ones.

Drawn poultry shall have all inedible organs removed, including the gall sac, all of the intestines, the windpipe, and the contents of the gizzard.

Partially drawn poultry cannot be lawfully sold.

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HEADACHE REMEDIES.

During the summer of 1910 quite a large number of headache remedies on sale in Maine were purchased. The investigation was made because of the large sale of these powerful drugs in the form of patent medicines and outside of physician's prescription.

The Harmfulness of Headache Mixtures.

The Bureau of Chemistry of the United States Department of Agriculture has made an extended statistical investigation into the harmful effects of acetanilide, antipyrine, and acetphenetidinum (Phenacetin) which is published as Bulletin 126 of the Bureau of Chemistry. A general and popular summary of this is published as Farmers' Bulletin 377 of the United States Department of Agriculture. The following is quoted from different parts of the bulletin. A copy of Farmers' Bulletin 377 can be obtained by addressing a member of Congress or of the Secretary of Agriculture, Washington, D. C.

"Acetanilid, antipyrin, and phenacetin (acetphenetidinum) are very commonly used in the preparation of mixtures intended for the relief of headache and other minor aches and pains. Thus there will often be seen upon the label of a

headache powder, beneath the name of the preparation, a statement like the following: 'Acetanilid, 240 grains per ounce.' This means that each ounce of the preparation contains 240 grains of acetanilid, or inasmuch as there are 480 grains in an ounce, that each powder is one-half acetanilid. Or the following may appear on the label: 'Phenacetin, 120 grains per ounce,' which means that each powder is one-fourth phenacetin.* These drugs are white powders with comparatively little taste, and are often described together, as they are similar in many respects and have somewhat the same effects on the human body."

"The unfavorable symptoms producted by these drugs affect principally the heart and circulation and through them other parts of the body, and are generally observed as the result of their ill-advised use in the form of 'patent' medicines for the relief of headache and other forms of pain. The symptom which occurs most frequently in poisoning by these drugs is blueness of the skin. The bluing of the skin is not a harmless manifestation, but it is due to destructive changes in the blood which are the direct result of the use of the drug, and it is accompanied by impoverishment of the blood."

"Acetanilid, antipyrin, and phenacetin were at first used almost exclusively for the reduction of fever, but as time went on they were employed less and less for this purpose, because of their weakening effects, particularly upon the heart and circulation. They gradually came to be used more and more for the relief of pain, however, and today this constitutes their chief field of usefulness. During the time when they were used principally for reducing fever they were employed under the supervision of the physician and were administered with medical skill and judgment, but as their power to relieve pain has become better known they have been used more and more by the people generally, without medical supervision, for the relief of headache and other minor ills."

"It has long been known that acetanilid, antipyrin, and phenacetin are habit-forming drugs, particularly acetanilid. The habit is usually acquired through the use of the remedy without the supervision of a physician for the relief of minor aches and pains, especially headache. Troubles of this kind

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* In the goods found in Maine this drug has borne its common name of acetphenetidin.

are peculiarly likely to return again and again, and the remedy has but a temporary effect; hence the dose must be repeated, and in time the patient may become dependent upon the drug. Furthermore, the ache or pain for which the medicine was first taken is often worse than ever after the effects of the remedy have passed away, because of the weakened condition of the system which may result from the use of these agents, and hence there is additional call for the remedy. Thus a habit may be established—more drug, impaired bodily health, lessened resistance, more pain, more drug."

The above in no way conflicts with the employment of these remedies by physicians. It clearly indicates that the ingestion of these powerful drugs without medical advice is dangerous.

Methods of Analysis.

Acetanilid was determined by Seidell's method (Jour. Amer. Chem. Soc. 1907, 29, 1091) in which it is saponified with dilute HCl (hydrochloric acid) and then titrated with a standard bromate of potash solution.

When acetphenetidin was present an accurate determination was not attempted as at present we have no very satisfactory method of determining it. It is, however, soluble in chloroform and most of the other materials entering into headache powders, as sodium bicarbonate, sugar, etc., are not. So a fairly accurate determination of the acetphenitidin can be made by leaching the powder with this reagent, evaporating off the chloroform, drying and weighing. When both acetanilid and acetphenetidin were present the chloroform extract represents both these ingredients. In case the acetphenetidin was present in small quantity it was not difficult to titrate the acetanilid and make an approximate separation.

Results of Analysis.

The results of the analysis are given in the tables on pages 92-96.

The goods were all lawfully labelled and accorded fairly with their professed strength. In some instances there was altogether too large a difference in the weights of the individual powders. The adult dose given in the U. S. Pharmacopoeia for acetanilide is 4 grains and for acetphenetidinum (phenacitine) 7½ grains. No single powder or pellet in those examined carried appreciably more than the adult dose.

Table showing the name, maker, and claims of headache remedies purchased in the summer of 1910, and the name and address of the Maine dealer.

Station number.	Brand, Maker and Claims.	Town and Dealer.
9105	A. D. S. Headache Wafers. American Druggists Syndicate, New York. "Each wafer contains 4 grains acetanilid."	Portland. John F. White.
8960	Antikamnia Tablets. The Antikamnia Chemical Co., St. Louis, Mo. "Contains 365 grains acetphenetidin U. S. P. per ounce."	Waterville. W. C. Hawker & Co.
8920	Brown's Headache Powders. Prepared for C. W. Brown Pharmacist, Bangor, Me. "Acetphenetidin 36½ grains in each ounce. Acetanilide 146 grains."	Bangor. C. W. Brown.
9029	Burn's Headache Powders. Frank P. Burns. The Kinsman Pharmacy, Augusta, Me. "An ounce of powder contains 44 grains phenacetine and 175 grains acetanilide."	Augusta. Frank P. Burns.
8904	Cephalgine Tablets. Manufactured for Cephalgine Co., Spencer, Mass. "Each tablet contains 2½ grains acetephenetidin (acetanilide derivative)."	Bangor. John P. Frawley.
8908	Dr. W. W. Eames Tonic Headache Wafers, formerly known as Celery Crackers. "Each wafer contains 3 grains acetephenetidine, U. S. P."	Bangor. John P. Frawley.
8907	Dr. Kohler's Antidote for Headache and Neuralgia. Kohler Manufacturing Co., Baltimore, Md. "Each powder contains acetephenetidine 5 3-5 grains combined with other ingredients making it the beneficial remedy that it is."	Bangor. John P. Frawley.
8921	Dr. Miles' Anti-Pain Pills. Dr. Miles Medical Co., Elkhart, Ind. "Contains 146 grs. acetanilid per avoirdupois oz. Contains no opium, morphine, heroin, cocaine or any other enslaving drugs. 2 grs. acetanilid in each pain pill."	Bangor, Carl S. Preble.
9028	Dr. Whitehall's Megrimine. Dr. Whitehall Megrimine Co., South Bend, Ind. "228 grains acetanilid in an ounce."	Augusta. Bowditch, Webster & Co.
8905	Dr. Whitehall's Megrimine. Dr. Whitehall Megrimine Co., South Bend, Ind. "Contains 228 grains acetanilid to the ounce. Used only in the white capsules combined with corrective and other remedies."	Bangor. John P. Frawley.
8958	Dr. Whitehall's Megrimine. Dr. Whitehall Megrimine Co., South Bend, Ind. "228 grains acetanilide in an ounce. (In the white capsules only)."	Waterville. W. C. Hawker & Co.
8923	Drake Headache Powders. Henry K. Wampole & Co., Philadelphia, Pa. "An ounce of powder contains acetanilide 164 grains; each powder 4½ grains."	Bangor. A. S. Chick.
8959	Drake Headache Powders. "Acetphenetidin 36½ grains in each ounce. Acetanilide 146 grains of powder."	Waterville. W. C. Hawker & Co.
8961	Eureka Headache Capsules. Dr. A. A. Lawrence, West Medway, Mass. "This capsule contains acetanilide 3 gr."	Waterville. W. R. Jones.

Table showing the results of examination of headache remedies purchased in the summer of 1910.

Station number.	Powders, Pills or Wafers. Cost of packag.	Pieces in package.	Weight each piece.	Acetanilide. Claimed.	Acetanilide. Found.	Remarks.
	Cts.		Grs.	Grs.	Grs.	
9105	10	4 wafers	10.5	4.0	4.1	Wafers varied in amount of acetanilide from 3.7 to 4.2 grains.
8960	25	12 tablets	5.2	–	–	Chloroform extract 4.2 grains.* Contains carbonates.
8920	25	10 powders	3.3	3.9	–	Chloroform extract 4.5 grains.*
9029	25	10 powders	8.6	3.2	3.8	Chloroform extract 5.1 grains.*
8904	25	25 tablets	6.7	–	–	Chloroform extract 2.76 grains.* Camphor present.
8908	25	12 tablets	6.6	–	–	Chloroform extract 3.6 grains.* Carbonates present.
8907	25	8 powers	6.8	–	–	Chloroform extract 6.3 grains.*
8921	25	25 pills	6.0	2.0	2.3	Carbonates present.
9028	50	10 capsules	7.3	3.4	3.0	
8905	50	8 small 6 large tablets	7.5	3.6	3.2	The large tablets weighed 9 grains.
8958	50	8 small 6 large capsules	7.2	3.4	3.0	Report is on small capsules.
8923	25	10 powders	11.1	3.8	3.6	
8959	25	10 powders	11.5	3.5	4.0	Chloroform extract 4.6 grains.*
8961	10	8 capsules	6.9	–	3.0	Carbonates present.

*See under Methods of Analysis page 91.

Table showing the name, maker, and claims of headache remedies purchased in the summer of 1910, and the name and address of the Maine dealer.

Station number.	BRAND, MAKER AND CLAIMS.	TOWN AND DEALER.
8910	Eureka Headache Powder. Eureka Headache Powder Co., Concord, N. H. "250 grains of acetanilide in each ounce of mixture. Contains no opium or other narcotic and leaves no unpleasant after-effect. No habit can be established by its use."	Bangor. East Side Pharmacy.
8957	Headache Powders. "Each powder contains 3½ grains of acetanilide."	Waterville. The Dorr Drug Store.
8925	Headache Powders. Prepared for Essex Pharmacy. "In each ounce of powder acetanilide 97½ grains."	Bangor. The Essex Pharmacy, Chas. L. Dakin.
8884	Headache Powders. "Each ounce contains 146 grains acetanilide."	Skowhegan. G. R. Fogg.
8876	Headache Powders. "Each powder contains acetanilide 3½ grains."	Waterville. Larkin Drug Co.
9002	Improved Headache Powders. Prepared for Martel's Pharmacy. "1 ounce powder contains acetanilide 164 grains; each powder 4½ grains."	Lewiston. Martel's Pharmacy.
9000	Lafayette Headache Powders. Lafayette Co., Montreal. Canada. "Each powder contains 3 grains of acetphenetidin U. S. P."	Lewiston. Martel's Pharmacy.
8999	Mathieu's Nervine Powders for Headache and Neuralgia. Favreau & Collette. Marlboro, Mass. Each powder contains 4 grains acetanilide."	Lewiston. Arthur Dussault.
8998	Moulton's Headache Powders. Prepared for Dr. Moulton. Lewiston, Me. "Acetphenetidin 36½ grains in each oz. Acetanilide 146 grains."	Lewiston. D. P. Moulton.
8877	Nervease Headache Powders. Nervease Co., Boston. Mass. J. B. Locke, Treasurer. "Each powder contains 4½ grains acetanilid,"	Waterville. Vose & Luques.
8909	Neu-Ral-Gine. Neuralgyline Co., Wheeling, W. Va. "Each ounce contains 175 grains acetanilide."	Bangor. John P. Frawley.
8906	Orangeine. Orangeine Chemical Co., Chicago, Ill. "Contains 230 4-10 grains of acetanilide in each ounce (480 grains) of compound. Formula since 1892: Acetanilide 2.4 grains; Soda Bi-carbonate 1.0 grain; Caffeine 0.6 grain; Homoe Trituration of blue plag. Mandrake, Nux Vomica 1.0 grains. Total only 5.0 grains."	Bangor. John P. Frawley.
9104	Otis Headache Powders. John C. Otis, Portland, Me. "Acetphenetidin 194 grains per average ounce."	Portland. John C. Otis.
8878	Phenyo-Caffein. "Acetanilid 25 pills, 50 grains, 2 grains each. Caffein, Camphor, q. s."	Waterville. Vose & Luques.
9030	Rexall Headache Wafers. United Drug Co., Boston, Mass. "Each ounce of these wafers contains 223 grains acetphenetidin (acetanilid derivative)."	Augusta. John Coughlin.

Table showing the results of examination of headache remedies purchased in the summer of 1910.

Station number.	Powders, Pills or Wafers.					Remarks.
	Cost of package.	Pieces in package.	Weight each piece.	Acetanilide.		
				Claimed.	Found.	
	Cts.		Grs.	Grs.	Grs.	
8910	25	10 powders	6.9	3.6	4.0	Carbonates present.
8957	25	12 powders	10.9	3.5	3.8	Carbonates present.
8925	25	10 powders	8.9	1.8	1.9	Carbonates present.
8884	20	10 powders	13.3	4.1	4.3	Carbonates present. Powders very unequal in weight, ranging from 11.5 to 14.3 grains.
8876	25	10 powders	9.6	3.5	3.7	Carbonates present.
9002	25	10 powders	10.8	3.7	4.2	Carbonates present.
9000	25	3 powders	14.4	–	–	Chloroform extract 3.3 grains.* Powders unequal in weight ranging from 13.3 to 16.1 grains.
8999	25	18 powders	5.2	4.0	3.4	Carbonates present.
8998	25	10 powders	12.0	3.7	4.2	Chloroform extract 5 grains.* Carbonates present.
8877	25	10 powders	7.2	4.5	4.1	Camphor present. No carbonates.
8909	25	20 tablets	5.1	2.0	2.1	Camphor present.
8906	25	6 powders	5.2	2.5	2.5	Tablets unequal ranging from 4.4 to 5.7 grains. Carbonates present.
9104	25	10 powders	9.4	–	–	Chloroform extract 4.1 to 4.8 grains.* Powders unequal ranging from 8.4 to 9.9 grains.
8878	25	25 pills	4.2	2.0	2.1	Camphor present.
9030	25	12 wafers	3.6	–	–	Chloroform extract 3.6 grains.* Powders entire soluble in chloroform.

* See under Methods of Analysis page 91.

Table showing the name, maker, and claims of headache remedies purchased in the summer of 1910, and the name and address of the Maine dealer.

Station number.	Brand, Maker and Claims.	Town and Dealer.
8922	Robinson's Headache Powders. Alex. M. Robinson, Bangor, Me. "Each powder contains 2¾ grains acetanilide. 100 grains acetanilide per ounce."	Bangor. Alex. M. Robinson.
8924	Shac Stearns' Headache Wafers. Zymole Co., distributors, New York. "Each wafer contains 4 grains of acetanilide with 1 grain of alkaloid caffeine."	Bangor. F. D. Wyman.
8962	Superior Headache Powders. Prepared for Geo. A. Daviau, Waterville. "Each ounce contains 146 grains acetanilid."	Waterville. Geo. A. Daviau.

Table showing the results of examination of headache remedies purchased in the summer of 1910.

Station number.	Powders, Pills or Wafers.					Remarks.
	Cost of package.	Pieces in package.	Weight each piece.	Acetanilide.		
				Claimed.	Found.	
	Cts.		Grs.	Grs.	Grs.	
8922	25	12 powers	11.8	2.7	2.6	Carbonates present.
8924	25	12 capsules	10.6	4.0	3.9	
8962	25	10 powders	11.6	3.5	3.9	Carbonates present.

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CARBONATED BEVERAGES.

Samples of carbonated beverages were purchased from quite a large percentage of the Maine bottlers during August and September, 1910. The results of the analyses are given in the tables which accompany this discussion.

Standards and Rulings for Carbonated Beverages.

The regulations under which carbonated beverages are sold are given in M. F. D. R. 19, which is as follows:

M. F. D. R. 19.

CARBONATED BEVERAGES.

The standards for carbonated beverages, root beers and similar beverages have not yet been determined upon. For the present these goods may be sold in Maine under the following general regulations.

Goods true to name need no label. Hence sirups made from cane sugar and flavored with extracts made from pure fruit oils or with pure, fruit juices, without added coloring matter can be lawfully sold without label of any kind.

Carbonated water flavored with extract made from pure fruit oils or with pure fruit juices, without any added coloring matter and sweetened with cane sugar can be lawfully sold in bottles or from fountains as "soda water" or "soda" without label of any kind.

Sirups or soda waters flavored with imitation flavors must be so labeled.

Sirups flavored with imitation flavors cannot be lawfully drawn from soda water fountains unless the fact is conspicuausly stated upon labels attached to the fountain.

If coloring matter is used, that fact must be stated. Food Inspection Decision 76 names the colors which may be lawfully used.

The words "imitation and colored" when used must be the same size and plainness of type as the name of the flavor, except that, for the present, in the case of bottled soda water where the label is upon the crown cap, the words "imitation flavor and color" may be in smaller letters than the flavor but they must be sufficiently large and plain as to be readily noted.

Benzoate of soda may be used in fruit sirups if the fact of its presence and amount is stated on the label. No other preservatives or chemicals (except as stated on page 1, F. I. D. 76) can be lawfully used under any circumstances.

Sirups containing benzoate of soda may be used in soda fountains provided a conspicuous sign is shown stating that fact, including its amount.

Sirups containing benzoate of soda may be used in bottled sodas, provided the fact and amount is stated on the label.

Trade marked or proprietary beverages sold under a descriptive name must be true to name.

For the present root beer, birch beer and ginger ale may be sold without a statement on the label that they are artificially colored and flavored.

If there is more than one label on imitation goods, the secondary label must correspond in fact with the principal label. Goods carrying "imitation flavor and color" on the crown cap, will not permit the use of a side label bearing a name unless it also carries "imitation flavor and color."

It is unlawful to substitute an imitation or adulterated article of food or drugs without calling attention to the fact of the subsitution even if the goods are properly and correctly labeled. For example, if pineapple soda is asked for, it is unlawful to sell a soda that contains an artificial flavor and color even though it be labeled "Pineapple soda imitation flavor and color," without calling attention to the fact that it is an imitation.

In Official Inspections 16, page 161, it was further stated:

In accordance with these provisions of the law and the action of the United States Board of Food and Drug Inspection, the use of benzoate of soda in vegetable products, alum in limited amount in pickles and saccharine in carbonated beverages is at the present time allowed in Maine provided the presence and amount are cleary and plainly stated on every package of foods containing these chemicals. No other chemicals can under any conditions be lawfully used in foods offered for sale in Maine. *This concession should not be taken as evidence that the Food and Drug Official of this State endorses or wishes to encourage the use of chemicals in foods.*

RESULTS OF THE EXAMINATION.

In discussing the results of the examination of the bottled soda waters and similar beverages offered in Maine there are a few general considerations which apply to nearly all of the bottlers.

Decorated Caps. Practically all of the bottlers in the State are using decorated caps which are made for them outside of the State. These usually carry the name of the beverage and the words "Artificial flavor and color." It happens either through carelessness in ordering or in not giving attention to the way in which their orders are filled, that this occasions misbranding on the part of the dealers and bottlers in two ways: it sometimes happens that plain caps without the words "artificial flavor and color are furnished when the bottler intended that they should carry that statement, and it also happens in the case of products which are not colored and in which a pure flavor is used, as for instance in Lemon Soda, that they are sometimes marked "artificial flavor and color" when in fact the goods are not artificially colored or flavored—a technical misbranding. In the present investigation only the first of these classes of misbrandings have been followed up.

Cream Soda. Under this heading practically all of the bottlers put up a rather sweet soda, with vanilla and perhaps some other flavoring added, which is absolutely innocent of any dairy product. Strictly speaking these goods are misbranded because they are called "Cream" Soda. How far the public is misled by this name cannot be well ascertained. The bottlers state that this Cream Soda has been put up by them for many years and that they have never thought of it as being a dairy product, and that it means to them a trade name and is not used with any thought of deceiving the public in any way.

One house, Caldwell Sweet of Bangor, adds to its side label a statement that this is not a dairy product. In all other cases it was sold simply as Cream Soda, although frequently accompanied by the words "artificial flavor and color."

Champagne Cider. With one exception the champagne cider found in the State was marked "artificial flavor and color." Strictly speaking this is misbranding even though the words "artificial flavor and color" are used, as it is not a cider but a made-up article. For the most part cider is apparently used as a foundation and then it is built up by the addition of other

materials. The percentage of alcohol varied in the champagne ciders from nothing up to something over one per cent. Where the words "artificial flavor and color" were put upon the goods that were marked "Champagne Cider" they have been practically passed, although strictly speaking they were not in accord with the law. In one instance salicylic acid was found in the champagne cider. This probably was not added by the bottler but was used as a preservative in the cider from which the compound was made.

Sarsaparilla Soda. For the most part this is not very different from Birch Beer. Sometimes it is put up with plain caps without the words "artificial flavor and color" upon them. Probably in no case does any sarsaparilla enter into the manufacture. The flavoring extracts used are a mixture and the dark color is obtained by caramel (burnt sugar). At the time that M. F. D. R. 19 was printed it was not known to the writer that sarsaparilla was a compound flavor and not true to name. For the present sarsaparilla may be sold as is now permitted for root beer, birch beer and ginger ale and without a statement on the label that it is artifically colored and flavored.

Harmless Colors. The following coal tar dyes, as well as harmless vegetable colors, are permitted in food materials provided that by the words "artificially colored" or some similar statement advice as to the nature of the goods is conveyed to the purchaser:

Red shades:

107. Amaranth.

56. Ponceau 3 R.

517. Erythrosin.

Orange shade:

85. Orange I.

Yellow shade:

4. Napthol Yellow S.

Green shade:

435. Light Green S. F. Yellowish.

Blue shade:

692. Indigo Disulfoacid.

Only these coal tar dyes either alone are mixed are permitted in foods and they must be made specifically for use in foods and bear a guarantee from the manufacturer that they are free

from subsidiary products and represent the actual compounds whose names they bear.

In the table coal tar colors are not always reported and caramel is only named in cases where there are special reasons for so doing. Not all the samples were tested for artificial color but enough of the different kinds from each bottler were tested to determine the nature of the dyes being used. Cases where unpermitted colors were used are being investigated. It is probable that the trouble is not so much with the bottlers as with the parties from whom the colors were purchased by the bottlers.

Alcohol. Ciders, root beers, ginger ales, and most of the proprietory articles were tested for alcohol and in many instances they were found to carry quite a large amount. At least, much more than is supposed to be present in an ordinary soft drink. The Maine Food and Drug Law does not require the naming of alcohol in foods. The flavor of some of these bottled soft beverages is dependent to a more or less extent upon the amount of alcohol present, and constant use of some of these containing approximately one per cent of alcohol, would quite readily be a means of developing a taste for alcoholic beverages.

In one instance bottled goods were labeled "Nerve Tonic." This would seem to imply that they were of medicinal value, and, as in medicines the percentage of alcohol must be stated, it was apparently adulterated and misbranded.

Saccharine. Something over 30 years ago, in an American laboratory, there was discovered a coal tar derivative which was found to be excessively sweet. This chemical, generally known in commerce as saccharine, is, roughly speaking, 500 times as sweet as sugar. This means that one pound of saccharine will sweeten as much water as 500 pounds of sugar. One whose taste is at all acute saccharine would never deceive, and for this reason, there is usually more or less sugar used in connection with it. In the bottled sodas here reported where saccharine has been found, sometimes only a slight amount is used and nearly or fully as much sugar occurs as is found in some of the cheaper soda waters which do not contain saccharine. In other instances, however, not more than a half or perhaps a third as much sugar is used as would be required in making a soda water sufficiently sweet, and the remainder is

made up with saccharine. This does not make sodas of good quality, but does make very unfair competition.

Investigation thus far made would seem to indicate that much of the saccharine used by Maine bottlers was on the advice of salesmen of manufacturers and dealers in this chemical. They have represented that it improved the flavor and quality of the goods. That this is not so and is a misrepresentation on the part of the salesman is evidenced by the fact that the best bottlers of high grade goods use only sugar and pure flavors. If an artificial sweetener of any kind is used that fact must be clearly stated on the label. It is held that the words "sweetener added" are not sufficient to indicate to the purchaser that a chemical substitute for sugar has been employed. The words "artificial" or "imitation" must appear upon the label in this connection.

Bottled sodas as ordinarily made, consisting of water, flavored, colored, sweetened and charged with gas, are not primarily used as foods; nevertheless when sugar is used as the sweetener they do possess a definite food value and when saccharine is substituted for the sugar they possess none. When sugar is used the sodas contain about the same proportion of solids as milk and while they cannot be compared to milk with respect to the fat and protein content, the sugar of sodas is quite comparable to the sugar contained in good milk. When substituting saccharine for sugar in bottled sodas, the manufacturer takes from the beverage the only constituent which has any value as a food and puts in its place a chemical which has no food value.

Fictitious and Incorrect Firm Names. During this investigation it was found to be an altogether too common practice for bottlers to use bottles bearing blown in the glass the names of other manufacturers. This is probably not done to deceive the public in any way but is through carelessness and a greater convenience. This is misbranding under the law and justly so. It is a great injustice to a manufacturer of high grade goods to have his bottles filled by makers of low grade, artificially sweetened and flavored sodas.

In the present investigations these cases were not even reported in all instances, and no hearings were appointed in regard to this phase of the question. A reasonable time will be given for the bottlers of the State to straighten out this particular matter. Unless the practice is discontinued, the execu-

tive of the Maine Food and Drug Law will consider it his duty to report such violations and bring cases against those found following the practice.

Another point to be remembered in the matter of fictitious firm names is the use by individuals of names purporting to be company names or names of corporations which have no legal existence. This is contrary to law and must stop.

Sanitary Conditions of Manufacture. While sanitation is not a part of the Maine Food and Drug Law, at the time when the inspector was collecting these samples he made some observations concerning the conditions under which the soda waters were bottled. In general the bottlers that were using straight sugar without saccharine, making their goods so that there was from 10 to 13 per cent solids, were much more careful in their manufacture than those putting out the goods of lower quality. Some of the goods were packed under very unsanitary conditions. In many of the bottling works, the bottles are merely rinsed. They, of course, should be thoroughly washed through two or three waters and sterilized. It is only in a few of the very best establishments that any such precautions are taken to insure cleanliness in the bottles. Flies with all the evils which are attendant upon them (see Official Inspections 24, pages 83 and 84) are altogether too much in evidence in many of the bottling works.

The three things that are being especially taken up at this time are the use of saccharine in the place of sugar, the use of dangerous coal tar dyes not intended for foods, and the use of artificial colors without statement on label. These violations are being thoroughly investigated and it may be found necessary to resort to prosecution.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total Solids Percent.	Remarks.
	Auburn, Vincent Bottling Co.			
8990	Birch Beer. Artificial color and flavor	1.034	9.5	Passed.
8991	Blood Orange. Artificial flavor and color.	1.039	10.7	Color Ponceau 3R. Passed.
8995	Champagne Cider. Artificial flavor and color.	1.043	11.5	Alcohol by volume 1.19 per cent. Not a straight cider.
8992	Cream Soda. Artificial flavor and color	1.036	10.4	Not a dairy product.
8993	Lemon Soda. Artificial flavor and color.	1.029	8.2	Contains no color, although claimed.
8994	Lemon Sour. Artificial flavor and color.	1.035	8.8	Color fast yellow. Adulterated.
8996	Root Beer. Artificial flavor and color.	1.045	8.9	Passed.
8997	Strawberry. Artificial flavor and color.	1.036	9.8	Color Ponceau 3R. Passed.
	Augusta, Glenwood Spring Co.			
9044	Birch Beer. Artificial flavor and color.	1.042	11.5	Passed.
9037	Blood Orange. Artificial flavor and color.	1.043	11.7	Color mixture of allowed colors. Passed.
9045	Chocolate. Artificial flavor and color.	1.042	11.6	Passed.
9033	Cream Soda. Artificial flavor and color.	1.041	11.2	Not a dairy product.
9033	Champagne Cider. Artificial flavor and color.	1.035	9.8	Salicylic acid present. Alcohol by volume 0.52 per cent. Adulterated.
9036	Lemon Soda. Artificial flavor and color.	1.042	11.9	Uncolored, though color claimed.
9039	Lemon Sour. Artificial flavor and color.	1.048	13.3	Color Napthol yellow S. Passed.
9040	Orange Phosphate. Artificial flavor and color.	1.062	16.5	Color mixture of coal tar dyes, probably amaranth and napthol yellow S. passed.
9034	Peach. Artificial flavor and color.	1.041	11.3	Color, mixture of allowed dyes. Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids Percent.	Remarks.
9042	Rasport. Artificial flavor and color.	1.043	12.1	Color amaranth. Passed.
9035	Root Beer. Artificial flavor and color.	1.042	7.8	Passed.
9046	Sarsaparilla. (with plain cap.)	1.043	11.9	Color caramel. Misbranded. Was intended to be branded "artificial color and flavor" like other goods. but label company sent plain caps through error. Explanation accepted.
9043	Strawberry. Artificial flavor and color.	1.040	11.2	Allowed coal tar colors. Passed.
9041	Vanilla Soda. Artificial flavor and color.	1.043	11.9	Color caramel. Passed.
	Bangor, Bangor Bottling Co.			
9141	Blood Orange. Artificial flavor and color.	1.037	9.7	Color Ponceau 3R. Passed.
9145	Cream Soda. Artificial flavor and color.	1.030	8.3	Not a dairy product.
9146	Drink. Rasport. Color added. Tasty.	1.037	10.2	Passed.
9148	Imperial. Bottled especially for select trade.	1.035	9.6	Colored with caramel. Not declared. Adulterated.
9139	Iron Brew.	1.033	9.0	Alcohol by volume 0.38 per cent. Trace of iron. Passed.
9144	Lemon Soda. Artificial flavor and color.	1.025	9.3	No artificial color, though claimed.
9142	Orange Cider. Artificial flavor and color.	1.037	10.1	Color napthol yellow S. Alcohol by volume 0.52 per cent. Passed.
9147	Peach Mellow. Artificial flavor and color.	1.040	11.2	Passed.
9137	Root Beer. Artificial flavor and color.	1.042	10.6	Alcohol 0.84 per cent. Passed.
9138	Sarsaparilla. Artificial flavor and color.	1.044	11.7	Passed.
9140	Strawberry. Artificial flavor and color.	1.035	9.1	Color amaranth. Passed.
9143	Vanilla Soda. Artificial flavor and color.	1.034	8.8	Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
	Bangor. Caldwell Sweet Co.			
	All goods here reported guaranteed under the Pure Food and Drugs Act, June 30, 1903. Serial No. 19502.			
9159	Blood Orange. Pure Extract. Artificial color.	1.035	9.9	Color acid magenta. Adulterated.
9161	Cherry Phosphate. Artificial flavor and color.	1.037	10.2	Color acid magenta. Adulterated.
9166	Cream Soda. Not a dairy product.	1.040	10.9	Name "Cream Soda" technical misbranding. Words "not a dairy product" shows that it was not intended to deceive.
9164	Ginger Ale. Spring water and the purest extracts are used in the manufacure of this beverage.	1.035	9.5	Alcohol by volume 0.19 per cent.
9156	Lemon Soda. Artificial color. Pure extracts.	1.037	10.6	No coal tar color found. Passed.
9160	Peach Mellow. Artificial flavor and color.	1.036	10.4	Color not one of the allowed colors. Adulterated.
9163	Pineapple. Artificial flavor and color.	1.037	10.3	Color fast yellow. Adulterated.
9158	Raspberry. Artificial flavor and color.	1.036	10.1	Color acid magenta. Adulterated.
9165	Sarsaparilla. Pure extract. Artificial color.	1.034	9.5	No coal tar color. Passed.
9162	Strawberry. Artificial flavor and color.	1.041	11.4	Color acid magenta. Adulterated.
9157	Vanilla. Pure extract. Artificial color.	1.032	10.9	No coal tar color. Passed.
	Bangor. Copeland & Co.			
9150	Blood Orange. Artificial flavor and color.	1.025	9.1	Color amaranth. Saccharine present. Adulterated.
9153	Cherry Phosphate. Artificial flavor and color.	1.027	7.3	Color amaranth. Saccharine present. Adulterated-ated.
9152	Cream Soda. Artificial flavor and color.	1.024	6.7	No coal tar color. Not a dairy product. Saccharine present. Adulterated.
9165	Ginger Ale. Artificial flavor and color.	1.034	8.9	No coal tar color. Passed.
9154	Lemon Soda. Artificial flavor and color.	1.025	7.1	Saccharine present. Adulterated.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
9149	Strawberry. Artificial flavor and color.	1.020	5.8	Color amaranth. Saccharine present. Adulterated.
9151	Vanilla Soda. Artificial flavor and color.	1.022	6.2	No coal tar color. Saccharine present. Adulterated.
	Bangor. F. E. Robinson.			
9253	Blood Orange. Artificial flavor and color.	1.036	9.3	Passed.
9250	Lemon Soda. Artificial flavor and color.	1.033	8.2	No artificial color. Passed.
9252	Sarsaparilla. Artificial flavor and color.	1.033	9.2	No coal tar color. Passed.
9251	Strawberry. Artificial flavor and color.	1.034	9.5	Color amaranth. Passed.
	Bangor. Ross Bottling Works.			
9173	Banana. Artificial flavor and color.	1.033	9.2	Saccharine present. Adulterated.
9177	Blood Orange. Artificial flavor and color.	1.034	9.7	Color amaranth. Saccharine present. Adulterated.
9175	Carbonated Condensed Apple Cider.	1.038	10.1	Alcohol by volume 0.26 per cent. No coal tar color detected. Not up to standard for cider. Adulterated and misbranded.
9171	Cherry Phosphate. Artificial flavor and color.	1.035	9.8	Color mixture of amaranth and napthol yellow S. Saccharine present. Adulterated.
9176	Cream Soda. Artificial flavor and color.	1.035	10.1	Not a dairy product. Saccharine present. Adulterated.
9172	Chocolate. Artificial flavor and color.	1.033	9.0	Saccharine present. Adulterated.
9178	Lemon Soda. Artificial flavor and color.	1.034	9.7	Saccharine present. Adulterated.
9169	Peach Mellow. Artificial flavor and color.	1.028	8.0	Color mixture of amaranth and napthol yellow S. Saccharine present. Adulterated.
9174	Pineapple. Artificial flavor and color.	1.035	10.1	Color napthol yellow S. Saccharine present. Adulterated.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table—Continued.

Station No	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
9170	Rasport. Artificial flavor and color.	1.037	10.4	Saccharine present. Adulterated.
9168	Sarsaparilla. Artificial flavor and color.	1.027	7.8	Saccharine present. Adulterated.
9167	Strawberry. Artificial flavor and color.	1.041	11.8	Color amaranth. Saccharine present. Adulterated.
	Bar Harbor. Mt. Kebo Spring Water Co.			
9272	Blood Orange. Artificial flavor and color.	1.017	5.1	Coal tar dye not allowed present. Saccharine present. Adulterated.
9271	Cream Soda. Artificial flavor and color.	1.015	4.4	Not a dairy product. Saccharine present. Adulterated.
9274	Lemon Soda. Artificial flavor and color.	1.017	5.1	Saccharine present. Adulterated.
9277	Nerve Tonic. Artificial flavor and color.	1.018	4.7	Name implies a medicine. Alcohol by volume 0.26 per cent. Not declared. Misbranded. Saccharine present. Adulterated.
9275	Raspberry. Artifical flavor and color.	1.014	4.3	Color amaranth. Saccharine present. Adulterated.
9273	Sarsaparilla. Artificial flavor and color.	1.018	4.9	Saccharine present. Adulterated.
9276	Strawberry. Artificial flavor and color.	1.018	5.1	Color amaranth. Saccharine present. Adulterated.
	Bath. Bath Bottling Co.			
9328	Blood Orange. Artificial flavor and color.	1.036	10.1	Unidentified coal tar color.
9333	Cream Soda. Artificial flavor and color.	1.029	8.1	Vegetable color. Not a dairy product.
9331	Lemon Soda. Artificial flavor and color.	1.040	13.5	No color found, though claimed.
9329	Lemon Sour. Artificial flavor and color.	1.045	12.3	Color napthol yellow S. Passed.
9336	Orange Phosphate. Artificial flavor and color.	1.048	13.0	Color acid magenta. Adulterated.
9327	Pineapple. Artificial flavor and color.	1.038	10.6	No coal tar color. Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
9330	Raspberry. Artificial flavor and color.	1.030	8.1	Color acid magenta. Adulterated.
9334	Sarsaparilla. Artificial flavor and color.	1.049	13.3	Passed.
9335	Strawberry. Artificial flavor and color.	1.048	13.2	Color acid magenta. Adulterated.
9332	Vanilla Soda. Artificial flavor and color.	1.050	9.6	Passed.
	Bath. Hartleb & Cheltra Co.			
9317	Banana. Artificial flavor and color.	1.039	11.0	Unidentified coal tar dye.
9315	Blood Orange. Artificial flavor and color.	1.044	12.5	Unidentified coal tar dye.
9326	Cherry Phosphate. Artificial flavor and color.	1.042	11.6	Color acid magenta. Adulterated.
9313	Cherry Phosphate. Artificial flavor and color.	1.038	10.6	Color acid magenta. Adulterated.
9320	Cream Soda. Artificial flavor and color.	1.049	13.6	Not a dairy product. No coal tar color found.
9316	Lemon Soda. Artificial flavor and color.	1.038	10.7	No color present, though declared.
9323	Lemon Sour. Artificial flavor and color.	1.047	12.7	Color napthol yelllow S. Passed.
9324	Mo Ko. Artificial flavor and color.	1.040	10.1	Alcohol by volume 0.76 per cent. Passed.
9318	Peach Mellow. Artificial flavor and color.	1.043	11.7	Color unidentified.
9314	Pineapple. Artificial flavor and color.	1.042	11.9	No coal tar color found.
9321	Raspberry. Artificial flavor and color.	1.045	12.3	Color acid magenta. Adulterated.
9325	Sarsaparilla. Artificial flavor and color.	1.049	13.1	Passed.
9322	Strawberry. Artificial flavor and color.	1.051	13.9	Unidentified coal tar dye.
9319	Vanilla Soda. Artificial flavor and color.	1.045	12.6	No coal tar color found. Passed.
	Belfast. Belfast Candy Co.			
9279	Belfast Pepso.	1.034	9.6	Alcohol by volume 0.26 per cent. Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
9287	Cherry. Artificial flavor and color.	1.037	10.4	Color acid magenta. Adulterated.
9286	Cream Soda. Artificial flavor and color.	1.039	11.6	Not a dairy product.
9281	Lemon Sour. Artificial flavor and color.	1.032	9.0	Passed.
9289	Peach. Artificial flavor and color.	1.035	9.5	Color acid magenta. Adulterated.
9283	Pineapple. Artificial flavor and color.	1.029	9.0	Passed.
9284	Raspberry. Artificial flavor and color.	1.024	7.2	Color acid magenta. Adulterated.
9282	Sarsaparilla. Artificial flavor and color.	1.023	6.9	Passed.
9285	Sherbet. Artificial flavor and color.	1.026	7.0	Alcohol by volume 1.08 per cent. Color acid magenta. Adulterated.
9288	Strawberry. Artificial flavor and color.	1.027	7.5	Color acid magenta. Adulterated.
9280	Vanilla Soda. Artificial flavor and color.	1.033	9.5	No coal tar color found. Passed.
	Biddeford. The Hanscom Bottling Company.			
9365	Blood Orange.	1.043	11.3	Color amaranth. Not declared on label. Adulterated.
9362	Cream Soda.	1.026	7.3	No coal tar color found. Not a dairy product.
9361	Lemon Soda. Artifically colored and flavored.	1.023	6.6	No color found though claimed on label.
9360	Lemon Sour. Artificially colored and flavored.	1.032	8.9	Color napthol yellow S. Passed.
9364	Pineapple. Artificially colored and flavored.	1.032	8.6	Passed.
9359	Sarsaparilla. Artificially colored and flavored.	1.026	7.2	Passed.
9363	Strawberry. Artificially colored and flavored.	1.030	8.2	Passed.
9366	Superior Quality Spruce Beer. Sparkling. Delicious. Blue Seal Supply Co., Boston.	1.030	7.2	Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
	Brunswick. Pine Spring Water Co.			
9338	Blood Orange. Artificial flavor and color.	1.053	14.4	Passed.
9343	Champagne Cider.	1.050	13.4	No alcohol. Imitation of Cider. Adulterated and misbranded.
9339	Chocolate. Artificial flavor and color.	1.053	13.8	Passed.
9342	Cream Soda. Artificial flavor and color.	1.053	14.5	Not a dairy product.
9341	Lemon Soda. Artificial flavor and color.	1.048	13.9	Color fast yellow. Adulterated.
9346	Orange Phosphate. Artificial flavor and color.	1.049	9.7	Color mixture of allowed colors. Passed.
9337	Raspberry. Artificial flavor and color.	1.050	13.6	Color amaranth. Passed.
9345	Sarsaparilla. Artificial flavor and color.	1.048	13.6	Passed.
9347	Strawberry. Artificial flavor and color.	1.042	11.9	Passed.
9344	Vanilla Soda. Artificial flavor and color.	1.056	15.0	No color, although artificial color declared.
9340	Wild Cherry. Artificial flavor and color.	1.056	15.3	Color amaranth. Passed.
	Lewiston. Maine Bottling Co.			
8989	Blood Orange. Artificial flavor and color.	1.029	8.2	Color orange I. Saccharine present. Adulterated.
8984	Chocolate. Artificial flavor and color.	1.029	8.5	Saccharine present. Adulterated.
8980	Cream Soda. Artificial flavor and color.	1.036	9.4	Not a dairy product. Saccharine present. Adulterated.
8987	Lemon Soda. Artificial flavor and color.	1.030	8.8	No artificial color, though claimed. Saccharine present. Adulterated.
8982	Raspberry. Artificial flavor and color.	1.032	8.3	Color acid magenta. Saccharine present. Adulterated.
8983	Roman Punch. Artificial flavor and color.	1.027	7.3	Color acid magenta. Saccharine present. Adulterated.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
8979	Root Beer. Artificial flavor and color.	1.035	8.4	Saccharine present. Adulterated.
8985	Sarsaparilla. Artificial flavor and color.	1.030	8.5	Saccharine present. Adulterated.
8981	Strawberry. Artificial flavor and color.	1.032	9.9	Color acid magenta. Saccharine present. Adulterated.
8988	Vanilla Soda. Artificial flavor and color.	1.035	9.9	Saccharine present. Adulterated.
8986	Wild Cherry. Artificial flavor and color.	1.031	8.9	Color acid magenta Saccharine present. Adulterated.
	Lewiston. Somoar Bottling Co.			
9010	Champagne Cider. Artificial flavor and color.	1.015	4.5	Dirty. Reserve sample contains flies. Alcohol present in small amount. Saccharine present. Adulterated.
9005	Cream Soda. Artificial flavor and color.	1.019	5.5	Not a dairy product. Saccharine present. Adulterated.
9008	Lemon Soda. Artificial flavor and color.	1.014	4.3	No artificial color present. though claimed. Saccharine present. Adulterated.
9003	Orange Soda.	1.015	4.5	Color Orange I. Color not declared. Saccharine present. Adulterated.
9007	Peach Mellow.	1.016	4.5	Coal tar dye present. Not declared on label. Saccharine present. Adulterated.
9004	Sparkling Cherry Phosphate. Artificial flavor and color.	1.017	4.8	Unidentified coal tar dye, Saccharine present. Adulterated.
9006	Strawberry. Artificial flavor and color.	1.015	4.4	Color unidentified coal tar dye. Saccharine present. Adulterated.
9009	Vanilla Soda.	1.019	5.5	Colored with caramel. Not declared. Saccharine present. Adulterated.
	Portland. Ingalls Bros Co.			
9103	Chocolate Mint, Liquid.	1.053	13.4	Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
9093	Fine Birch Beer.	1.020	5.7	Saccharine present. Adulterated.
9099	Fine Blood Orange. Artificially colored and flavored.	1.021	5.6	Saccharine present. Adulterated.
9094	Fine Fruit Nectar.	1.057	15.1	Alcohol by volume 0.79 per cent. Color amaranth. Not declared. Misbranded.
9100	Fine Imitation Pineapple. Sweetener added.	1.022	5.6	Saccharine present. Passed.
9101	Fine Lemon Soda.	1.022	5.4	Saccharine present. Adulterated.
9095	Fine Sarsaparilla.	1.020	5.5	Colored with caramel. Saccharine present. Adulterated.
9097	Fine Strawberry. Artificially colored and flavored.	1.019	5.4	Color amaranth. Saccharine present. Adulterated.
9102	Fine Vanilla.	1.022	5.8	Saccharine present. Adulterated.
9096	Jersey Creme. Artificially colored. Contains no milk, cream or dairy product.	1.060	13.7	Alcohol by volume 0.38 per cent. Color amaranth. Small amount of saccharine present. Technically adulterated. Passed because of high sugar content.
9098	Peach Mellow. Artificial.	1.020	5.3	Unallowed coal tar color and saccharine present. Adulterated.
9092	Queen Sherbert.	1.042	10.1	Contains alcohol. Passed.
	Portland. C. E. Odiorne Bottling Co.			
9085	Rienzi Birch.	1.036	10.5	Passed.
9088	Rienzi Blood Orange. Artificial flavor and color.	1.039	9.3	Color amaranth. Passed.
9087	Rienzi Cream Soda.	1.033	8.8	Not a dairy product. Unidentified color present.
9091	Rienzi Lemon.	1.035	9.0	Passed.
9089	Rienzi Raspberry. Artificial flavor and color.	1.038	9.5	Color amaranth. Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids percent.	Remarks.
9084	Rienzi Root Beer.	1.041	10.1	Alcohol by vol. 0.19 percent. Passed.
9086	Rienzi Sarsaparilla.	1.031	10.0	Colored with caramel. Not declared. Adulterated.
9090	Rienzi Strawberry. Artificial flavor and color.	1.037	9.7	Passed.
	Portland. Portland Bottling Co.			
9129	Blood Orange. Artificial flavor and color.	1.034	9.1	Color amaranth. Passed
9131	Cream Soda. Artificial flavor and color.	1.034	9.2	Not a dairy product.
9134	Lemon Soda. Artificial flavor and color.	1.035	9.2	No artificial color present though claimed.
9133	Lemon Sour. Artificial flavor and color.	1.034	9.3	Color napthol yellow S Passed.
9132	Root Beer. Artificial flavor and color.	1.036	9.7	Contains no alcoho. Passed.
9128	Sarsaparilla. Artificial flavor and color.	1.035	9.4	Passed.
9130	Strawberry Artificial flavor and color.	1.034	9.1	Color amaranth. Passed
	Rockland. Hewitt Bottling Co.			
9302	Blood Orange. Artificial flavor and color.	1.027	8.0	Unidentified coal tar color Saccharine present. Adulterated.
9301	Cream Soda. Artificial flavor and color.	1.028	8.3	Not a dairy product. No artificial color though claimed. Saccharine present. Adulterated.
9300	Lemon Soda. Artificial flavor and color.	1.028	9.8	Color napthol yellow S. Saccharine present. Adulterated.
9299	Sarsaparilla. Artificial flavor and color.	1.029	8.6	Saccharine present. Adulterated.
9303	Strawberry. Artificial flavor and color.	1.032	9.1	Color probably Ponceau 3R. Saccharine present. Adulterated.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
9304	Superior Quality Premium Punch. Artificial flavor and color.	1.021	6.3	Alcohol by volume 0.38 per cent. Saccharine present. Adulterated.
	Rockland. Knox County Bottling Co.			
9312	Sarsaparilla. Artificial flavor and color.	1.017	5.0	Saccharine present. Adulterated.
9311	Wild Cherry. Artificial flavor and color.	1.017	5.1	Unidentified coal tar dye. Saccharine present. Adulterated.
	Rockland. Standard Bottling Co.			
9298	Bittermead. A pleasant tonic beverage. Formula: Fluid extract calamus, compound tincture gentian, tincture angostura bark, extract vanilla bean, prune juice, coriander (soluble essence), anise (soluble essence) burnt sugar, syrup, fruit acid, carbonated water.	1.037	11.5	No alcohol. Passed.
9296	Cherry Phosphate. Artificial flavor and color.	1.035	8.6	Unidentified coal tar dyes
9293	Cream Soda. Artificial flavor and color.	1.033	9.7	No artificial color, though claimed. Not a dairy product.
9292	Jersey Creme. The perfect drink. Artificial color.	1.043	10.9	Alcohol by volume 0.91 per cent. Passed.
9294	Lemon Soda. Artificial flavor and color.	1.034	9.3	Color napthol yellow S. Passed.
9295	Orange Soda. Artificial flavor and color.	1.034	9.7	Color apparently Orange G. which is not an allowed color.
9297	Strawberry. Artificial flavor and color.	1.037	10.6	Passed.
	Waterville. Gideon Mahew.			
8952	Birch Beer. Artificial flavor and color.	1.034	9.3	Passed,
8954	Chocolate. Artificial flavor and color.	1.047	12.3	Passed.
8955	Peach Mellow. Artificial flavor and color.	1.042	11.2	Mixture of allowed colors. Passed.
8951	Pineapple. Artificial flavor and color.	1.042	11.2	Passed.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table—Continued.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
8950	Raspberry. Artificial flavor and color.	1.041	11.0	Color amaranth. Passed.
8949	Rasport. Artificial flavor and color.	1.031	8.5	Color amaranth. Passed.
8953	Root Beer. Artificial flavor and color.	1.039	12.5	Passed.
8956	Strawberry. Artificial flavor and color.	1.040	10.6	Passed.
	Waterville. Mineral Spring Soda Co.			
9050	Birch Beer. Artificial flavor and color.	1.040	11.0	Passed.
9051	Blood Orange. Artificial flavor and color.	1.037	10.3	Color amaranth and Orange I, Mixture. Passed.
9054	Cherry Phosphate. Artificial flavor and color.	1.042	12.3	Color amaranth. Passed.
9052	Chocolate. Artificial flavor and color.	1.041	11.6	Passed.
9048	Cream Soda. Artificial flavor and color.	1.043	11.9	Not a dairy product.
9053	Lemon Soda. Artificial flavor and color.	1.041	11.3	Color napthol yellow S. Passed.
9049	Root Beer. Artificial flavor and color.	1.038	10.0	No alcohol. Passed.
9047	Strawberry. Artificial flavor and color.	1.041	6.1	Color amaranth. Passed.
	Waterville. J. Tardif & Son.			
8943	Birch Beer. Artificial flavor and color.	1.021	5.9	Passed.
8939	Blood Orange. Artificial flavor and color.	1.016	4.6	Unidentified coal tar dye. Saccharine present. Adulterated.
8944	Cherry Phosphate. Artificial flavor and color.	1.016	7.4	Saccharine present. Adulterated.
8946	Cream Soda. Artificial flavor and color.	1.018	5.1	Not a dairy product. Saccharine present. Adulterated.

Table Showing the Results of Examination of Bottled Carbonated Beverages Purchased in the Summer of 1910. The samples are arranged alphabetically by towns where the goods were made. Two Massachusetts manufacturers at end of table.—Concluded.

Station No.	Name of the town and maker and brand.	Specific gravity.	Total solids per cent.	Remarks.
8948	Lemon Soda. Artificial flavor and color.	1.017	4.8	No color found, though claimed. Saccharine present. Adulterated.
8945	Lemon Sour. Artificial flavor and color.	1.016	4.8	Saccharine present. Adulterated.
8948	Peach. Artificial flavor and color.	1.020	5.6	Unidentified cool tar dye. Saccharine present. Adulterated.
8947	Pineapple. Artificial flavor and color.	1.017	4.7	Saccharine present. Adulterated.
8938	Raspberry. Artificial flavor and color.	1.016	4.7	Color amaranth. Saccharine present. Adulterated.
8937	Root Beer. Artificial flavor and color.	1.019	4.8	Unidentified coal tar dye. Passed.
8940	Strawberry. Artificial flavor and color.	1.015	4.4	Color amaranth. Saccharine present. Adulterated.
8941	Vanilla Soda. Artificial flavor and color.	1.019	5.2	Saccharine present. Adulterated.
	Cliquot Club Co., Mass. Bought from E. W. Church, Augusta, Me.			
9032	Celebrated Cliquot Club Extra Quality Blood Orange. Artificial color. Serial No. 10681.	1.045	11.6	Color amaranth. Passed.
9031	Celebrated Cliquot Club Extra Quality Birch Beer. Serial No. 10681.	1.046	12.1	Passed.
	Chelmsford, Mass. Chelmsford Spring Co. Bought from G. L. Cannon, Waterville, Me.			
8935	Birch Beer Soda Water.	1.055	14.5	Passed.
8932	Blood Orange.	1.054	13.8	Color amaranth. Not declared. Adulterated.
8936	Cream Soda.	1.051	13.3	Not a dairy product. Color caramel. Not declared. Adulterated.
8933	Root Beer.	1.057	12.9	Passed.
8934	Sarsaparilla Soda Water.	1.047	12.1	Color caramel. Not declared. Adulterated.

ICE CREAM.

In August samples of ice cream were purchased in Augusta, Bangor, Lewiston, Old Town, Orono, Portland, Waterville and at the Waterville Fair Grounds. The results of the examination are given in the table on pages 120 to 122.

STANDARDS FOR CREAM AND ICE CREAM.

The standards * fixed for cream and ice cream in this State are as follows:

b. CREAM.

1. *Cream* is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean and contains not less than eighteen (18) per cent of milk fat.

f. ICE CREAMS.*

1. *Ice cream* is a frozen product made from cream and sugar, with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat. A limited amount of gelatine, starch, eggs or other healthful food constituents may be added to ice cream without statement of fact, and such goods may be called Ice Cream provided the required per cent of milk fat is maintained. If imitation flavoring materials are used, the label must state that fact, as in the case of imitation extracts.

2. *Fruit ice cream* is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat.

3. *Nut ice cream* is a frozen product made from cream, sugar, and sound, nonrancid nuts, and contains not less than twelve (12) per cent of milk fat.

At soda fountains, ice cream rooms, etc., if it is desired to sell frozen products that do not conform to the standards for ice cream, conspicu-

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**Imitation ice cream.* Frozen products which contain less milk fat than the standards require, cannot be lawfully sold as ice cream and the word *cream* cannot be lawfully used upon the label or in any way in connection with such goods, unless it is qualified by some such words as "imitation" or "substitute." Thus a frozen product similar to ice cream or fruit or nut ice cream, except that it carries less milk fat than the standards, may be lawfully labeled "Imitation ice cream" or "Ice cream substitute." If an imitation ice cream contains imitation flavoring matter, this fact must be plainly stated on the label.

ous signs showing exactly what is being served must be displayed and orders for ice cream can not be lawfully filled by serving substitutes without explaining what they are.

The regulation relative to ice cream and ice cream substitutes applies equally to hotels and restaurants. All statements upon bills of fare, etc., must be in accord with the above.

There has been a marked advance in the quality of ice cream sold in Maine, and at present apparently practically all of the ice cream sold in Maine is of lawful standard or approximately of lawful standard. It was found that one ice cream, No. 9118, Old Town, was too low because of a mistake of the creamery in furnishing a thin cream instead of a thick cream. It is equally interesting to note that No. 9115, Bangor, was very much higher in milk fat because of the opposite mistake, using a very rich cream instead of a 20 per cent cream as ordinarily used.

From a number of samples which were taken at Waterville and at Portland that ran 1.0, 2.0 or 3.0 per cent below the standard there seemed to be little question but that this was the fault of the companies furnishing the cream. It seems that at least two of the large creameries in the State have been putting out a cream which carries only 17 per cent instead of 18 per cent butter fat. It is practically impossible to make a lawful ice cream from 17 per cent cream. When ice cream is next investigated the quality of the cream which is furnished by the venders of cream will be taken into very careful consideration. While it is lawful for a dealer to sell a cream containing less than 18 per cent butter fat, it must be labeled to show its exact strength. This year in cases where ice creams ran even as much as 3 per cent below the standard they have been passed. Another year not so much leniency will be shown.

Two instances of adulterated cream are still being investigated and prosecution is probable.

Even more important than conforming to the standard is cleanliness in preparing and dispensing ice cream. Unfortunately there is no sanitary law in Maine, but at the time when the samples were taken the inspectors made certain notes of conditions. While there were some things to criticize, on the whole conditions were fairly good. A thorough renovation of premises and improvement of methods, however, would be helpful in a large majority of the cases.

Results of Analyses of Ice Creams Collected in the Summer of 1910. Arranged alphabetically by the towns where the goods were purchased.

Station number.	Town and Dealer.	Milk fat per cent.	Remarks.
9020	Augusta, F. P. Burns	16.7	Above standard. Made by H. J. Marden.
9017	Augusta, N. T. Folsom & Son	14.2	Above standard.
9019	Augusta, J. G. Johnson	13.7	Nearly up to standard. Passed.
9021	Augusta, H. J. Marden	17.0	Above standard.
9016	Augusta, Willis R. Partridge	16.2	Above standard.
9018	Augusta, C. H. Pettis	6.3	Mr. Pettis made affidavit that this was goods which he instructed his clerk not to sell. He gave his formula which would make a 14 per cent ice cream if strictly followed.
9112	Bangor, Geo. N. Broundas	17.4	Above standard.
9106	Bangor, Floros Bros	12.8	Below standard. Dealer warned. Passed.
9109	Bangor, C. A. Fowler	20.4	Above standard.
9111	Bangor, Geo. E. Lufkin	15.6	Above standard.
9114	Bangor, Joseph Kminsky	9.6	Case being followed up. Prosecution probable.
9115	Bangor, Costa Makanna	28.2	By mistake 40 per cent cream was used to make this cream instead of the 20 per cent usually used.
9107	Bangor, Olympia Ice Cream Parlor, Lewis Facos	15.6	Above standard.
9113	Bangor, Union Station Dining Room, Armstrong Co	15.5	Above standard.
9108	Bangor, V. S. Vafiades	16.9	Above standard.
9110	Bangor, Weferling Original Vienna Cafe, L. Hegwein, Prop	17.2	Above standard.
9116	Bangor, Harry A. Witham	12.2	Below standard. Dealer warned. Passed.
9117	Bangor, F. D. Wyman	14.0	Just standard.
8973	Lewiston, Boston Reliable Candy Co	12.9	Below standard. Dealer warned. Passed.
8974	Lewiston, O. Cote	13.3	Below standard. Dealer warned. Passed.
8976	Lewiston, A. L. Grant	13.0	Below standard. Dealer warned. Passed.
8975	Lewiston, Olympia Confectionery Store	12.5	Below standard. Dealer warned. Passed.
8977	Lewiston, Lewiston Candy Kitchen	11.7	Below standard. Dealer warned. Passed.
8978	Lewiston, Samuel Stewart	16.9	Above standard.
9121	Oldtown, F. X. Boutin	16.0	Above standard.
9120	Oldtown, Harry Goldsmith	11.0	Below standard. Dealer warned. Passed.

Results of Analyses of Ice Creams Collected in the Summer of 1910. Arranged alphabetically by the towns where the goods were purchased.—Continued.

Station number.	Town and dealer.	Milk fat per cent.	Remarks.
9118	Oldtown, Morin Bros	10.2	Case investigated. Probable error on part of creamery furnishing cream. Case passed.
9119	Oldtown, A. C. Mutty	14.8	This cream was purchased by Mutty from Jordan Bros., Oldtown. Above standard.
9063	Orono, J. Edward Jordan	15.5	From top of freezer. Above standard.
9065	Orono, J. Edward Jordan	14.3	From bottom of same fteezer as No. 9063. Above standard.
9064	Orono, Chas. F. Nichols	13.0	Sign displayed giving formula showing ice cream to be below standard in butter fat.
9075	Portland, Eddington Ice Cream Parlor	11.6	Below standard. Dealer warned. Passed.
9081	Portland, W. A. Flaherty	9.4	Ice cream made by Geo. F. Soule, Portland. Prosecution probable.
9083	Portland, Longfellow Square Fruit Store	12.8	Made by Simmons & Hammond, Portland. Below standard. Both dealer and manufacturer warned. Passed.
9082	Portland, I. F. Lord & Son	13.9	Nearly standard. Passed.
9078	Portland, D. K. Macris	11.6	Made by Simmons & Hammond, Portland. Below standard. Both dealer and manufacturer warned. Passed.
9079	Portland, Park Drug Store	19.4	Above standard.
9076	Portland, Geo. E. Sawyer	13.0	Below standard. Dealer warned. Passed.
9074	Portland, Simmons & Hammond	11.0	Below standard. Dealer warned. Passed.
9077	Portland, John J. Thuss	13.2	Below standard. Dealer warned. Passed.
9022	Waterville, Geo. A. Daviau	14.8	Above standard.
8930	Waterville, W. A. Hager	12.1	Below standard. Dealer warned. Passed.
8929	Waterville, W. C. Hawker & Co.	13.9	Nearly standard. Passed.
9025	Waterville, E. W. Luques	13.9	Nearly standard. Passed.
8928	Waterville, Silvio Pagnucci	16.7	Above standard.
9023	Waterville, A. J. Ponsant	11.5	Below standard. Dealer warned. Passed.
9027	Waterville, E. L. Simpson	13.0	Below standard. Dealer warned. Passed
9024	Waterville, Chas. Sirois	14.0	Just standard.
8926	Waterville, Joseph Vantrosco	11.3	Below standard. Dealer warned. Passed.
8931	Waterville, Verzoni Bros	14.5	Above standard.
9069	Waterville Fair Grounds, L. P. Burns, Union, Me	3.4	Mr. Burns is a farmer. Did not know of the law. Was really selling frozen custard. After his attention was called he labeled it "Made from cream, milk and eggs and below standard."

Results of Analyses of Ice Creams Collected in the Summer of 1910. Arranged alphabetically by the towns where the goods were purchased.—Concluded.

Station number.	Town and dealer.	Milk fat per cent.	Remarks.
9068	Waterville Fair Grounds, A. M. Dingley, Portland...............	11.8	Made by Simmons & Hammond, Portland. Below standard. Both dealer and manufacturer warned. Passed.
9070	Waterville Fair Grounds, H. N. Doughty, Providence, R. I......	13.2	Below standard. Dealer warned. Passed.
9072	Waterville Fair Grounds, Philip Geguere, Waterville	12.6	Purchased from Vose & Luques, Waterville. Both dealer and manufacturer warned. Passed.
9073	Waterville Fair Grounds, Ed. Morrison, Oakland...	9.9	Dealer could not be found in Oakland.
9071	Waterville Fair Grounds, E. L. Simpson, Waterville	11.8	Below standard. Dealer warned. Passed.

Evaporated Milk in Ice Cream.

It was found during the investigations of ice cream this summer that at least one manufacturer was making a practise of using evaporated milk in ice cream at times during the summer when the cream supply was short. As evaporated milk only carries from 8 to 10 per cent of milk fat and the standard for ice cream requires 14 per cent it is an impossibility to make a standand ice cream from this product even when undiluted. In future investigations of ice cream such an explanation will not be accepted as satisfactory when ice cream is found to be below the standard.

The Serial Number is Sometimes Misleading.

Explained below are two very important points to which careful attention should be given not only by the food and drug trade but by the purchasing public.

A serial number appearing upon a package is absolutely no surety that the contents may be used with safety either as a food or as a medicine. Mixtures and compounds containing chemicals not allowed in foods are being sold for the purpose of admixture with foods under proprietary and trade names and often carry a serial number.

The serial number was intended to be a convenient means of identification by which a product could be traced at once to its source and any fault placed with the manufacturer. Any producer of a definite food or drug product can, by filling a general guaranty, with the U. S. Secretary of Agriculture and applying for a serial number, obtain the privilege of using upon his goods the legend "Guaranteed by .... under the Food and Drugs Act, June 30, 1906. Serial No. ....." This statement simply means that the manufacturer guarantees the goods in the package to be as represented by the label. It does not mean that the Government guarantees the goods in any way or assumes any responsibility for them. A package containing the most deadly poison known can as legally bear a guaranty and serial number as a package containing the most healthful food product. In either case if the contents of the package are in accord with the label upon the outside the package can be legally sold.

A compound consisting in whole or in part of a chemical which must, under the Food and Drug Laws, be named upon the package, can be legally sold bearing the guaranty and serial number but this does not give manufacturers the right to use this compound in food products without stating, the presence of the chemical or drug under consideration. For example, it was found during the inspection of bottled sodas that some of the manufacturers were using sweeteners which were guaranteed under the National Food and Drugs Act and bore serial numbers. They consisted, however, either in whole or in part of the chemical ordinarily known as saccharine the presence of which, under both the National and the Maine Food and Drug Laws, must be stated upon the labels of goods which contain it.

In South Dakota the Food Commissioner has recently sent out a notice concerning various vegetable canning compounds which are being sold in that state guaranteed and bearing serial numbers and which are composed principally of borax. While we have no knowledge that such a material is being sold at present in Maine, it is well to be on the watch for such frauds. It has been shown without question that borax is injurious and it is unlawful to offer for sale goods which contain it. Housewives are warned against using anything of the kind in home preparations as vegetables canned with the aid of this chemical would be dangerous to health. The use of such a material by a food manufacturer is prohibited by the law. The fact that such a preparation may lawfully bear the U. S. serial number does not in any way permit or imply that it may be lawfully added to a food product.

All correspondence relative to the laws regulating the sale of food and drugs, feeding stuffs, fertilizers, seeds and creamery glassware, should be addressed to

Director Chas. D. Woods,
Orono, Maine.

December, 1910

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.

CHAS. D. WOODS, Director

Analysts

James M. Bartlett	Herman H. Hanson
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Raymond P. Norton	Alfred K. Burke

Official Inspections.

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SEED INSPECTION.

The Legislature of 1897 enacted a law regulating the sale of agricultural seeds. This law was satisfactory as far as it went, and resulted in an improvement in the character of the seed sold in the State. It did not provide for an inspection and as time passed the moral effect of the law to some extent and with some dealers grew less. To remedy this, the Legislature of 1905 passed an additional section to the law, calling for an inspection somewhat similar in requirements to that of the laws regulating the sale of commercial fertilizers, foods and feeding stuffs. The chief requirements of the law follow. The full text of the law will be sent on application.

Chief Requirements of the Law.

Kind of Seeds Coming Under the Law. The law applies to every lot of seeds, containing one pound or more, of cereals, grasses, forage plants, vegetable and garden plants, but does not apply to sweet corn, trees, shrubs and ornamental plants.

The Guaranty. Every lot of seed sold, offered or exposed for sale must be accompanied by a written or printed guaranty of the percentage of purity. Dealers may base their guaranty upon tests conducted by themselves, their agents, or by the Director of the Maine Agricultural Experiment Station; provided, that such tests shall be made under such conditions as the said director may prescribe. The rules for testing the purity of seeds are given in Bulletin 36, a copy of which will be sent on application to the Station. Maine dealers will probably find it impossible to buy outside of the State, grass seed whose purity is guaranteed, hence Maine jobbers will have to fix the guaranty either by analysis made by themselves or by someone else. *The guaranty must be in accord with fact.* Maine retail dealers will have no difficulty in buying properly guaranteed seeds from Maine jobbers.

The Brand. A seed to be lawfully sold or offered for sale in Maine must carry "a written or printed guaranty of its purity and freedom from foreign matter." It is not enough that the package carries the figures but they must be accompanied by explanatory words naming the seed and what the figures mean. For example,—a bag of timothy seed labeled "99.5 per cent" is not lawfully branded; it should be labeled in some such a way as the following:—"Timothy, 99.5 per cent pure."

Analysis of Unguaranteed Seeds.

The Station examines as promptly as possible all samples of seeds sent by Maine dealers to assist them to decide (1) whether they should or should not purchase the seed, and (2) what guaranty of purity should be placed upon the seeds. When the seed law first went into effect the Director of the Station decided to make free analysis of seed for dealers and did so for a number of years. The law requires that all analyses made by the Station under the law be published. This led to some dealers not submitting samples for examination because the published results of the analysis of a seed which they did not purchase because of its poor quality as disclosed by the analysis, were used against them by competitors. For this and other reasons it was decided not to make further free examination of unguaranteed seeds.

The Station, however, examines at cost samples of unguaranteed seeds, submitted to it by dealers, the quality of which they wish to know. The results of these analyses are not published and are considered as a private matter between the dealer and the Station. The charge for the examination of large seeds such as timothy, clover, etc., is 50c. per sample. The charge for the examination of a fine seed like redtop is $1.00 for a reasonably clean sample. The report of the examination gives in addition to the percentages of purity, the character of the foreign matters and of the foreign seeds. There are no requirements as to the way in which the samples for paid analyses are drawn and it is optional with the dealer submitting the sample whether he does or does not give information as to the source of the sample.

The Maine Jobber and the Seed Trade.

At present it is impossible for the Maine dealer, wholesale or retail, to obtain guaranteed seeds from outside of the State. The retail dealer can purchase guaranteed seed from Maine wholesale houses, and the Station advises him so to do. The wholesale dealer must look to the outside. Three years ago the Director of the Station assumed a certain responsibility as to the statement of analysis given by two or three of the leading seed houses of the country. It however does not seem wise for him to continue this practice. Therefore any guaranties which a Maine dealer places upon seeds based upon out-of-state firms statements as to their purity is entirely at the risk of the Maine dealer. After consulting with some of the larger houses within the State the following suggestions were made to importing houses by the Director of the Station.

"I suggest that when a car of seed goes forward to you that you request your shipper to send you a type sample of the car stating the name of the shipper, the kind of seed and its special brand if any, the analysis which they place upon it if any, the lot number, and car number. When this sample is received by you send it to me. I will then have it examined. This analysis will be made at your expense (usually 50 cents to $1.00) and the results will be reported to you. I will retain the sample here to check up with the samples to be sent to us from the car.

As soon as the car is received by you or by your customer, have a sample taken from not less than six packages and sent to us, also accompanied by the name of the shipper, the kind of seed and its special brand, the lot number and car number. This sample we will give prompt, free analysis and report the results to you. If there is a discrepancy between the analysis of the type sample submitted and the samples taken directly from the car, the guaranty, of course, would have to be changed before the goods could be sold, but it would give you a basis upon which to make a claim against the shipper as to quality.

My reason for writing the above is that it is my desire not only to enforce the provisions of the Maine seed law, but to protect, as far as possible, Maine wholesale handlers of seed against the irresponsibility which cleaners of seed profess."

Free Analysis of Seeds.

Samples of agricultural seeds on sale in Maine, taken in accordance with directions below, will be examined as promptly as possible and the results reported free of charge.

Directions for Sampling Seeds. The contents of packets should be emptied out, mixed thoroughly by stirring, and small quantities taken from different parts of the mixture to make the sample.

If seeds are in bulk or in large packages, take handfuls at random from the top, middle and bottom, and from these, after mixing, take the sample for testing.

Samples of seeds for free analysis must be taken in the presence of a disinterested and reputable witness, who shall certify that the sample was taken in his presence according to these directions. The sample must be enclosed in an envelope or other suitable package, securely fastened and sealed in the presence of the witness. The names of the sender and witness must be written on the outside of package, which shall be sent to the station prepaid. Samples shall weigh approximately as follows:

Grasses, clovers and all seeds of similar size, 2 ounces.

Cereals, vetches, beet "balls" and all larger seeds, 4 ounces.

Rye grasses, bromes, sorghums, and millets, 2 ounces.

All the smaller vegetable seeds, 1 ounce.

All the larger vegetable seeds except beet "balls," 2 ounces.

Sending Samples. Every sample of seeds sent to the Station for free analyses should be in a securely fastened package and must be accompanied by a statement certifying to the fairness of the sample, the name and address of the dealer, the name under which the seed is sold or offered for sale, the lot number and exact copy of any other marks on the package and the guaranteed percentage of purity. Blanks for the purpose of forwarding samples of seeds will be furnished on application to the Station.

The Written Guaranty the Retailer's Safeguard.

Although the written guaranty clause of the Maine food and drug law applies only to the sale of food and drugs, discretion is given to the Director regarding prosecutions under other laws. No prosecutions will be made against any handler of agricultural seeds within the State *provided* he obtain at the time of purchase, a guaranty *personally signed in ink* that the goods are in conformity with the Maine law regulating the sale of agricultural seeds. The guaranty to be of value should identify and may be attached to the bill of sale, invoice, bill of lading, or other schedule, giving the names, marks upon the packages and quantities of the seeds sold.

Testing Seeds at Home.

It is important to the user of seeds not only to know their percentage of purity and what kind of weeds they carry, but to also know something of their vitality. In the case of seeds there are at least three ways whereby the user may be injured. A seed which carries foreign matter of any kind, in any considerable amount, is correspondingly lowered in value. But there is another reason which is more important than the money consideration, and that is that the weed seeds which the seeds contain may be pernicious. For example,—clover seed frequently carries plaintain seed. If this plaintain seed is the door-yard variety which is present practically all over Maine, there would be comparatively little harm from using clover seed which contained it. On the other hand—lance leaved plaintain or rib grass is not abundant in Maine. It is an undesirable plant and using seed carrying it might introduce a weed into land which is at present free from it. It is important that the farmer should know the vitality as well as the purity of the seed that he is to

use. No matter how pure a seed may be, if half of it will not sprout it has no more value than if the seed were half chaff.

While it is not easy to make an exact purity test, it is not difficult for a farmer to so acquaint himself with the seeds that he is ordinarily using that by the help of an ordinary reading or magnifying glass he will be able to tell whether the seed in question contains any considerable amount of impurities. If the seed is spread out upon a white plate, a little practice will enable a farmer to see whether a given seed is reasonably pure or not, and he will soon learn to detect the more common foreign seeds.

Vitality of Seeds.

It is much easier for the farmer to test the vitality of seed than to make a purity examination. The following simple instructions for performing germination tests at home without any special apparatus will enable the farmer to learn for himself whether the seed that he is using has good vitality or not. Germination tests may be made in two ways,—the so-called blotting paper methods, and the sand method. In making the germination test with blotting paper, blue blotting paper of common weight, cut into strips about 6 x 19 inches, should be used. This is laid folded twice so as to get a piece of three thicknesses and about six inches square, on an ordinary dinner plate or platter. The seeds if small are placed on the top of the paper and if large between the folds. The paper is kept moist (not soaked) and at a temperature of 70 to 80 degrees F.

If only a vitality test is desired the blotting paper method is preferable, but if it is desired to know how many seeds may be expected to grow, the sand method is in some ways preferable. In this method a thin layer of fine sand is sprinkled on the bottom of a flat dish and the seeds to be tested placed on it under a thin covering of sand. This must be kept moist and well shaded and at a somewhat higher temperature than in the first case.

At the end of every second day in the case of some seeds, and the third day in the case of those germinating more slowly, the sprouted seeds should be removed from the blotters or the sand and counted, the per cent being readily found by referring back to the number of seeds which were taken for the test. If 100 seeds are used, the number that sprout give the vitality per cent.

Seed Oats.

Quite a large number of complaints were sent to the Experiment Station during the late spring months that oats which had been sown failed to germinate. All of these cases which were reported to the Experiment Station were investigated and in every instance it was found that bleached, clipped oats had been used for seed. In no case was it found that the local dealer had purchased seed oats but that he had purchased for general feeding purposes. Nor was it clear that in any case the person who purchased from the local dealer with the intention of using the oats for seed made known to him at the time of purchase what his object was in buying the oats. Naturally good, selected, heavy, seed oats sell at a price very considerably in advance of oats intended for feeding purposes only. It is certainly very bad economy on the part of the farmer to purchase oats for seeding purposes that were not specially grown and specially cleaned for seed.

The Results of Inspection.

The inspection of grass seed sold in Maine in 1910 were made almost entirely by the seed analyst whose experience makes it possible for him to tell almost at a glance whether a seed is or is not what it is guaranteed. In all suspicious cases in which he was in doubt samples were taken. It therefore happens that the samples, the analyses of which are here reported, are the doubtful ones that were found within the State and represent a selection made from very many hundred lots.

Several samples of alsike from the same source were found to be misbranded in that their percentage of purity was lower than claimed. In all these cases, however, it was traced back to the fault of a very careful shipper and was undoubtedly due to a clerical error in the office. No prosecution was made.

There has been a very remarkable improvement in the quality of grass seed which is handled and there were practically no violations of the law in this State in 1910. In only two instances were seeds found unguaranteed and these were through an oversight on the part of the handler. This improved condition of Maine grass seed has been brought about chiefly by patient education. It has seldom been necessary in all the years that the law has been in effect to resort to prosecution.

Description of the Tables.

The table on pages 132 and 133 contain a list of the 81 kinds of weed seeds obtained from seeds which were examined in the year 1910. They are arranged alphabetically in accordance with the English name. As the common name differs in different parts of the country, the scientific name following the classification given in the last edition of Gray's Manual of Botany is given for the purpose of identification.

The table on pages 138 to 140 summarizes the results of the examinations of samples of seeds examined by the Station in 1910.

The table on pages 134 to 137 contain the analyses of samples of seeds collected by the inspector in 1910. The inspector only drew samples from lots of which he was doubtful as to their corresponding to their guaranty.

A list of weed seeds found in seeds examined in 1910.

Nomenclature, Gray's Manual, 17th Edition, 1908.

Common name.	Scientific name.
American Pennyroyal	Hedeoma pulegioides (L.) Pers.
American wild mint	Mentha canadensis (L.) Brig.
Barnyard grass.	Echinochloa crusgalli (L.) Beauv.
Black medick	Medicago lupulina L.
Blue Vervain	Verbena hastata L.
Bracted plantain.	Plantago aristata Michx.
Canada thistle	Cirsium arvense (L.) Scop.
Catnip	Nepeta cataria L.
Charlock	Brassica arvensis (L.)
Chicory	Cichorium intybus L.
Common chickweed	Stellaria media (L.) Cyrill.
Common mallow	Malva rotundifolia L.
Corn spurry	Spergula arvensis L.
Crabgrass	Digitaria sanguinalis (L.) Scop.
Crane's bill	Geranium maculatum L.
Dandelion	Taraxacum officinale Weber.
Dock	Rumex Sp.
Ergot	*Claviceps purpurea (Fr.) Tul.
Evening primrose	Oenothera biennis L.
False flax	Camelina miscrocarpa Andrz.
Field dodder	Cuscuta arvensis Beyrich.
Field poppy	Papaver rhoeas L.
Five finger	Potentilla monspeliensis L.
German millett	Setaria italica—var.
Goosefoot	Chenopodium album L.
Green foxtail	Setaria viridis (L.) Beauv.
Heal-all	Prunella vulgaris L.
Hedge mustard	Sisymbrium officinale (L.) Scop.
Indian mallow	Abutilon theophrasti Medic.
Knot grass	Polygonum aviculare L.

Common name.	Scientific name.
Lady's thumb	Polygonum persicaria L.
Marsh elder	Iva ciliata Willd.
Mayweed	Anthemis cotula L.
Mint	Mentha Sp.
Moth mullein	Verbascum blattaria L.
Mouse ear chickweed	Cerastium vulgatum L.
Mustard	Brassica nigra (L.) Koch.
Night flowering catchfly	Silene noctiflora L.
Nightshade	Solanum nigrum L.
Old-witch grass	Panicum capillare L.
Ox-eye daisy	Chrysanthemum leucanthemum L.
Pennsylvania persicaria	Polygonum pennsylvanicum L.
Penny cress	Thlaspi arvense L.
Peppergrass	Lepidium virginicum L.
Pigweed	Amaranthus retroflexus L.
Pimpernel	Anagallis arvensis L.
Plantain	Plantago major L.
Purslane	Portulaca oleracea L.
Ragweed	Ambrosia artemisiifolia L.
Raspberry	Rubus idaeus L.
Rat's tail fescue grass	Festuca myuros L.
Rattle snake grass	Glyceria canadensis (Michx.) Trin.
Ribgrass	Plantago lanceolata L.
Rugel's plantain	Plantago rugelii Done.
Sedge	Carex, unidentified
Sheep sorrel	Rumex acetosella L.
Shepherd's purse	Capsella bursa-pastoris (L.) Medic.
Slender crabgrass	Digitaria filiformis (L.) Koeler.
Spiny sida	Sida spinosa L.
Spurge	Euphorbia preslii. Guss.
Stink grass	Eragrostis magastachya (Koeler) Link.
Tumbleweed	Amaranthus graecizans L.
Unknown Sp.	Unidentified.
Vaginia three seeded murcury	Acalypha virginica L.
White vervain	Verbena urticaefolia L.
Wild buckwheat	Polygonum convolvulus L.
Wild carrot	Daucus carota L.
Wormseed mustard	Erysimum cheiranthoides L.
Yarrow	Achillea millefolium L.
Yellow daisy	Rudbeckia hirta L.
Yellow foxtail	Setaria glauca (L.) Beauv.
Yellow rocket	Barbarea vulgaris R. Br.
Yellow wood sorrel	Oxalis corniculata L.

* Sclerotia of the fungus.

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official samples taken in 1910.

Station Number.	Kind of seed, name and town of dealer. Special marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	ALSIKE CLOVER.	%	%	%	%	%
6681	B. R. Adams, Lincoln.					
	"Ace" Alsike.	95.0	94.3	0.6	3.9	1.2
6510	Wm. F. Chick, Bangor.					
	Diamond Alsike.	98.5	98.2	0.6	1.1	0.1
6511	Lotus Alsike.	95.8	95.7	C.5	3.7	0.1
6512	Prime Alsike.	98.0	97.7	0.6	1.6	0.1
	Oscar Holway Co., Auburn.					
6616	"A" Alsike.	98.0	95.1	1.0	3.3	0.6
6617	Anchor Alsike.	99.0	98.1	0.5	1.3	0.1
6662	"A" Alsike.	96.0	95.8	0.8	3 1	0.3
6632	"Ward" No. 12 Fancy Alsike.	98.0	97.3	0.2	1.1	1.4
6669	Kidder Brothers, Peru.	96.0	96.3	0.6	2.6	0.5
	Merrill, Runnels & Mayo, Waterville.					
6684	Ace Alsike, No. 86929	96.0	96.9	0.5	1.9	0.7
	Patten Grange Store, Patten.					
6691	Alsike 12.	99.0	97.8	0.2	1.1	0.9
	Rowe & Bartlett, Springvale.					
6356	K. & W. Alsike G63.	96.0	87.7	1.1	9.9	1.3
	Shaw, Hammond & Carney, Portland.					
6588	Keystone Alsike.	98.0	98.0	0.1	1.5	0.4
6621	The Swan & Sibley Co., Belfast.	96.0	96.6	0.2	2.4	0.8
6572	H. B. Whipple, Bingham.	96.0	96.6	0.7	1.9	0.8
	RED CLOVER.					
	B. R. Adams, Lincoln.					
6630	"Eclipse" Clover.	97.8	98.7	0.5	0.5	0.3
	Wm. F. Chick, Bangor.					
6514	Lotus Clover.	98.5	98.6	0.4	0.5	0.5

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official samples taken in 1910—Continued.

Station number.	Kind of seed, name and town of dealer. Special marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	RED CLOVER.—Continued.					
6515	Diamond Brand Clover.	99.5	99.7	0.1	0.2	0. 0
6516	Medium Clover.	99.7	99.5	0.2	0.1	0.2
6688	Dexter Co., Operative Store, Dexter.	99.0	98.4	0.3	0.1	1.2
	Oscar Holway Co., Auburn.					
6661	"Anchor" Red Clover.	99.0	99.3	0.2	0.1	0.4
6694	N. Y. Red Clover.	99.0	98.9	0.6	0.2	0.3
6668	Kidder Brothers, Peru.	99.0	99.0	0.2	0.6	0.2
	Merrill, Runnels & Mayo, Waterville.					
6685	Ace Clover. C76491.	99.0	98.8	0.5	0.5	0.2
	Shaw, Hammond & Carney, Portland.					
6585	Red Clover 76146.	99.0	99.6	0.1	0.1	0.2
6618	The Swan & Sibley Co., Belfast.	99.0	99.7	0 2	0.1	0.0
6571	H. B. Whipple, Bingham.	99.0	99.5	0.2	0.2	0.1
	MAMMOTH CLOVER.					
	Caribou Grange Store, Caribou.					
6692	Globe Brand Mammoth Clover.	94.0	99.7	0.1	0.2	0.0
6513	Wm. F. Chick, Bangor.	99.7	99.5	0.4	0.1	0.0
	Shaw, Hammond & Carney, Portland.					
6586	Mammoth Clover, 76134.	99.0	99.5	0.1	0.2	0.2
	Hungarian.					
	Oscar Holway Co., Auburn.					
6612	"W. H. M." Hungarian.	–	98.2	0.4	0.0	1.4
6619	The Swan & Sibley Co., Belfast.	96.0	97.5	0.9	0.1	1.5

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official samples taken in 1910—Continued.

Station number.	Kind of seed, name and town of dealer. Special marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	REDTOP.					
	Geo. B. Haskell Co., Lewiston.					
6568	X Redtop.	80.0	76.6	9.3	10 5	3.6
6569	XX Redtop.	82.0	74.8	8.3	14.7	2.2
6570	XXX Redtop.	-	96.7	2.4	0.0	0.9
	Oscar Holway Co., Auburn.					
6666	Redtop Lot No. 92248.	90.0	93.6	4.7	0.8	0.9
	Kendall & Whitney, Portland.					
6601	V. D. Redtop.	92.0	91.4	5.9	0.6	2.1
6602	K. R. Redtop, R. T. 92014.	78.0	84.8	3.7	10.2	1.3
6670	Kidder Brothers, Peru.	82.0	79.7	8.3	10.1	1.9
6622	The Swan & Sibley Co., Belfast.	90.0	91.7	4.3	3.1	0.9
6574	H. B. Whipple, Bingham.	92.0	88.7	7.9	2.1	1.3
	TIMOTHY.					
	B. R. Adams, Lincoln.					
6679	"Bison" Timothy.	97.7	97.7	0.7	1.1	0.5
	Wm. F. Chick, Bangor.					
6517	50 Fancy Timothy.	99.6	99.6	0.2	0.1	0.1
6518	50 Fancy Timothy.	99.6	99.6	0.2	0.2	0.0
6519	W. F. C. Timothy.	98.5	98.4	0.5	0.9	0.2
6520	S. W. F. Choice Timothy.	99.1	99.1	0.1	0.7	0.1
	L. Decker & Son, Clinton.					
6650	Keystone Brand Timothy.	99.4	99.6	0.2	0.2	0.0

Table showing the kind of seed, name and location of dealer, and the results of the analyses of official sample taken in 1910—Concluded.

Station Number.	Kind of seed, name and town of dealer. Special marks.	Purity.		Impurities.		
		Guaranteed.	Found.	Inert matter.	Harmless—Foreign.	Noxious—Foreign.
	TIMOTHY.—Continued.					
	Oscar Holway Co., Auburn.					
6611	"Veribest" Timothy.	98.0	98.7	0.2	1.0	0.1
6613	"Anchor" Timothy.	99.0	99.5	0.1	0.4	0.0
6614	"Bell" Timothy.	99.0	99.3	0.2	0.4	0.1
6615	"X Ray" Timothy.	97.0	98.1	0.5	1.0	0.4
6659	"Bell" Timothy.	99.0	99.2	0.2	0.4	0.2
6660	"Veribest" Timothy.	98.0	93.9	0.2	0.8	0.1
6663	Pine Tree Timothy. Lot No. 60784.	99.0	99.8	0.1	0.½	0.½
6664	"Bison" Timothy Lot No. T69859.	96.0	98.8	0.7	0.3	0.2
6693	"Chic" Timothy.	97.8	97.9	0.7	1.2	0.2
6667	Kidder Brothers, Peru.	99.4	99.4	0.3	0.2	0.1
	Merrill, Runnels & Mayo, Waterville.					
6683	Pine Tree Timothy.	99.0	99.4	0.3	0.2	0.1
6686	Globe Timothy Lot No. 69583.	99.0	99.8	0.1	0.1	0.0
	Shaw, Hammond & Carney, Portland.					
6587	Keystone Timothy Lot No. 69601.	99.0	99.6	0.2	0.1	0.1
6620	The Swan & Sibley Co., Belfast.	99.0	99.4	0.1	0.5	0.0
6573	H. B. Whipple, Bingham.	99.0	99.4	0.4	0.1	0.1
	JAPANESE MILLETT.					
	Wm. F. Chick, Bangor.					
6690	J. M. 81062.	96.0	96.3	0.4	0.0	3.3
	Oscar Holway Co., Auburn.					
6665	Mark A2.	91.0	93.3	0.4	0.2	6.1
	Shaw, Hammond & Carney, Portland.					
6655	Keystone Brand.	99.0	99.4	0.1	0.0	5.0

Table showing results of examination of samples of seed in 1910.

Names of weeds.	Kinds of seed and number of samples.									
	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millett.	Crimson clover.
Number of samples examined	51	46	8	3	82	31	2	11	12	1
American pennyroyal	-	-	-	-	1	-	-	-	-	-
American wild mint	-	-	-	-	7	2	-	-	-	-
Barnyard grass	5	-	-	-	-	-	-	3	-	-
Black medick	4	30	-	3	-	-	-	-	-	-
Blue vervain	3	-	-	-	9	2	-	-	-	-
Bracted plantain	4	-	-	-	1	-	-	-	-	-
Canada thistle	-	6	-	-	-	-	-	-	-	-
Catnip	3	2	-	-	-	-	-	-	-	-
Charlock	1	-	-	-	-	-	-	1	1	-
Chicory	1	-	-	-	-	-	-	-	-	-
Common chickweed	1	-	-	1	-	-	-	-	-	-
Common mallow	2	-	-	-	-	-	-	-	-	-
Corn spurry	-	-	-	1	-	-	-	-	-	-
Crabgrass	6	-	-	-	-	-	-	5	4	-
Crane's bill	-	-	-	-	-	-	-	-	-	1
Dandelion	-	-	-	-	-	-	2	-	-	-
Dock Sp.	31	33	7	-	12	-	-	-	-	-
Ergot	-	-	-	-	37	31	2	-	-	-
Evening primrose	3	1	-	-	54	2	-	1	-	-
False flax	-	7	-	-	-	-	-	-	-	-
Field dodder	4	-	-	-	-	-	-	-	-	-
Field poppy	1	-	-	-	-	-	-	-	-	-
Five finger	-	10	-	-	54	15	-	-	-	-
German millett	1	-	-	-	-	-	-	-	-	-
Goosefoot	16	16	2	1	47	-	-	9	1	-
Green foxtail	46	8	4	-	11	-	-	12	2	-
Heal-all	7	-	-	2	2	-	-	1	-	-
Hedge mustard	-	3	-	-	3	-	-	-	-	-

Table showing results of examination of samples of seed in 1910—Continued.

Names of weeds.	Kinds of seed and number of samples.									
	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millet.	Crimson clover.
Indian mallow	–	–	–	–	–	–	–	–	–	3
Knot grass	5	–	–	–	–	–	–	1	2	–
Lady's thumb	20	–	1	–	–	–	–	8	7	–
Marsh elder	1	–	1	–	–	–	–	–	–	–
Mayweed	3	9	–	–	9	–	–	–	–	–
Mint Sp	–	–	–	–	7	13	–	–	–	–
Moth mullein	–	–	–	–	10	8	–	–	–	–
Mouse ear chickweed	–	14	–	1	–	21	1	–	–	–
Mustard	2	–	–	–	2	–	–	1	–	–
Night flowering catchfly	12	44	2	1	4	–	–	–	–	1
Nightshade	4	–	–	–	–	–	–	–	–	–
Old-witch grass	9	10	–	–	17	8	–	7	–	–
Ox-eye daisy	–	1	–	–	–	–	–	–	–	–
Pennsylvania persicaria	–	–	–	–	–	–	–	2	11	–
Pennycress	–	1	–	–	–	–	–	–	–	–
Peppergrass	1	15	–	1	33	4	–	–	–	–
Pigweed	7	3	1	–	5	–	–	3	–	–
Pimpernel	1	–	1	–	1	–	–	–	–	–
Plantain	–	5	–	–	–	8	1	–	–	–
Purslane	–	1	–	1	1	1	1	–	–	–
Ragweed	2	–	–	–	–	–	–	3	10	–
Raspberry	–	1	–	–	–	–	–	–	–	–
Bat's tail fescue grass	–	–	–	–	–	2	–	–	–	–
Rattlesnake grass	–	–	–	–	2	–	–	–	–	–
Ribgrass	27	2	2	3	4	1	–	–	–	–
Rugel's plantain	32	9	1	1	63	7	–	–	–	–
Sedge Sp	1	6	–	–	45	23	2	–	–	–
Sheep sorrel	16	36	2	3	20	4	2	–	–	1
Shepherd's purse	–	3	–	–	2	2	1	–	–	–

Table showing results of examination of samples of seed in 1910—Concluded.

Names of weeds.	Kinds of seed and number of samples.									
	Red clover.	Alsike clover.	Mammoth clover.	White clover.	Timothy.	Redtop.	Kentucky blue grass.	Hungarian.	Millett.	Crimson clover.
Slender crabgrass	8	1	–	–	2	–	–	6	1	–
Spiny sida	7	–	–	–	–	–	–	–	4	–
Spurge	3	–	1	–	–	–	–	–	1	–
Stink grass	–	–	–	–	–	1	–	–	–	–
Tumbleweed	1	–	–	–	1	–	–	1	–	–
Unknown Sp	–	–	–	–	1	1	–	1	1	1
Vaginia three seeded mercury	2	–	–	–	–	–	–	3	–	–
White vervain	6	–	–	–	3	–	–	1	–	–
Wild buckwheat	–	–	–	–	–	–	–	–	1	–
Wild carrot	10	–	–	–	–	–	–	–	–	–
Wormseed mustard	–	2	–	–	3	–	–	–	–	–
Yarrow	–	–	–	–	–	31	–	–	–	–
Yellow daisy	–	–	–	–	32	1	–	–	–	–
Yellow foxtail	6	–	–	–	–	–	–	9	12	–
Yellow rocket	1	4	–	–	4	–	–	–	–	–
Yellow wood sorrel	–	–	–	–	2	–	–	–	–	–

[385-4-10]

University of Maine

MAINE
AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE.
CHAS. D. WOODS, Director.

EXERCISES

AT THE

Twenty-fifth Anniversary

OF THE

ESTABLISHMENT

OF THE

Maine Agricultural Experiment Station

HELD AT THE

University of Maine,

March 9, 1910.

AND

A Brief Historical Sketch

OF THE

Station.

STATION STAFF, 1885.

WHITMAN H. JORDAN,	*Director and Chemist*
JAMES M. BARTLETT,	*Assistant Chemist*
GILBERT M. GOWELL,	*Field and Feeding Experiments*

STATION STAFF, 1910.

ADMINISTRATION	CHARLES D. WOODS, Sc. D.,	*Director*
	HARRY M. WOODS, A. B	*Asst. to Director*
	BLANCHE F. POOLER,	*Stenographer*
	RALPH K. JONES, B. S.,	*Librarian*
	CHARLES J. DUNN,	*Treasurer*
	GRACE M. COLBURN,	*Bookkeeper*
BIOLOGY	RAYMOND PEARL, Ph. D.,	*Biologist*
	FRANK M. SURFACE, Ph. D.,	*Associate*
	MAYNIE R. CURTIS, A. M.,	*Assistant*
	WALTER ANDERSON,	*Poultryman*
	LOTTIE E. McPHETERS,	*Computer*
CHEMISTRY	JAMES M. BARTLETT, M. S.,	*Chemist*
	HERMAN H. HANSON, M. S.,	*Associate*
	ALBERT G. DURGIN, M. S.,	*Assistant*
	HARRY ANDERSON,	*Laboratory Assistant*
ENTOMOLOGY	EDITH M. PATCH, B. S.,	*Entomologist*
	OSKAR A. JOHANNSEN, Ph. D.,	*Associate*
	ALICE W. AVERILL,	*Laboratory Assistant*
HORTICULTURE	WALTER W. BONNS, B. S.,	*Associate*
PLANT PATHOLOGY	WARNER J. MORSE, M. S.,	*Pathologist*
	CHARLES E. LEWIS, Ph. D.,	*Associate*
	JOHN SUMMERS,	*Laboratory Assistant*
HIGHMORE FARM	WELLINGTON SINCLAIR,	*Superintendent*

ROYDEN L. HAMMOND,	*Seed Analyst and Photographer*
HENRY A. MILLETT,	*Meteorological Observer and Janitor*

TWENTY-FIFTH ANNIVERSARY EXERCISES OF THE MAINE AGRICULTURAL EXPERIMENT STATION.

The act establishing the Maine Agricultural Experiment Station and Fertilizer Control was signed by Hon. Frederick Robie, then Governor of Maine, March 3, 1885. Therefore, the Station was 25 years old on the 3rd of March, 1910. It seemed wiser, however, to hold the anniversary exercises in connection with Farmers' Week at the University of Maine. For this reason the day selected was Wednesday, March 9, 1910. The exercises were held in the Chapel of the University. There was a large attendance of the friends of the Station and among them many who had long been acquainted with its work. The Director of the Experiment Station presided. The proceedings follow.

THE PROCEEDINGS.

Director Woods—I am very glad, friends, that you are here with us this afternoon to help us celebrate the twenty-fifth anniversary of the Maine Agricultural Experiment Station. It is a little difficult to realize that with agriculture, the oldest of the arts, it is so comparatively recently that any very definite work either in the way of instruction or investigation has been undertaken. The first American College of Agriculture celebrated its fiftieth anniversary about two years ago. It will be two years before the fiftieth anniversary of the signing of the Act which established the land grant colleges. It was only about 60 years ago that a body of German farmers got together and decided that they needed the help of investigation along agricultural lines in order to solve the problems by which they were confronted. This led to the establishment of the first agricultural experiment station in the world at the village of Moeckern just outside of the city of Leipzig in the province of Saxony, Germany.

The work in the spread of experiment stations proceeded slowly. Thirty-five years ago this winter the Connecticut legislature passed an act which established the first agricultural experiment station in America.

Twenty-five years ago this winter the Maine legislature established the Maine Agricultural Experiment Station and Fertilizer Control. This act was signed by Governor Frederick A. Robie the third day of March, 1885, so that it is now six days beyond the day when the Maine Agricultural Experiment Station was really 25 years old.

It has seemed to us fitting that we should celebrate this very important event by calling some attention to those earlier days. So much is going on, so fast is the world moving, that it is very easy to forget the beginnings, small though they were, which have been leading up to the improved agricultural conditions of this State and the whole country as the result of this great experiment station movement.

We hoped that Governor Robie might possibly be with us, though with his advancing years we had very little actual expectation. We had thought that Governor Fernald would be with us also, but at the last he was prevented. He has, however, sent his private secretary to speak to us on this occasion. I take pleasure in introducing Mr. Kendall L. Dunbar, Private Secretary to His Excellency.

Remarks by Kendall L. Dunbar, Private Secretary to the Governor.

Mr. Chairman, Ladies and Gentlemen:—The Governor told me this was the twenty-fifth anniversary of the Experiment Station and I allowed that that was probably the reason that he was sending me over here to speak to you—somewhat in the nature of an experiment. I wish to state, however, that it was imperative for the Governor to be elsewhere today.

A Governor, I find upon more or less close association with one, is expected to know all about everything that comes along. He must be ready on tap to talk learnedly about the past and present, of theology, law, commerce, education, farming, politics, the rights of women and the wrongs of men, and other live subjects, as well as some which, no doubt, he wishes were dead and buried. These are some of the things that a Governor is supposed to know, and more than that, at his peril to

forecast with accuracy the future of all these topics—and not get on the wrong side. But, of course, a private secretary it is not to be assumed knows all these things, so that you will only expect me to speak briefly, and not much more than to bring you the most cordial and hearty greeting and good will of Governor Fernald, chief executive of the State of Maine, which I do.

I appreciate the fact and I am proud to speak for a governor who on all occasions and in all places, when it seemed fitting, has never hesitated to say to the people of his State that his home always has been, is now, and he hopes and expects always will be, upon the farm.

I believe, I am confident, that that will reach the right place in the hearts of many a young man in the State, and go far to hold or send him to a work that more and more demands brains, energy, and common sense to achieve success—not in the field of law or medicine, of the ministry or commerce, but right here on God's broad acres in the State of Maine.

Twenty-five years, Mr. Chairman, is a short span in the life of a State, but in that period Maine has grown in wealth, has increased in valuation $175,000,000. We may well believe that many of those millions are due to the broad influence, radiating to the four corners of the State, of this great institution that has been reared in the valley of the Penobscot by the faith and sacrifices of our own people. And I believe we are just entering upon an era of prosperity and of usefulness—for we must not inculcate the folly of measuring our progress wholly by the yardstick—that the next quarter of a century will eclipse by vast strides any like period in the history of the State. And why? Our fathers builded upon the firm foundation of a Constitution that declared its purpose to be to establish justice, insure tranquility, promote the common defense and secure to themselves and their posterity the blessings of liberty. Upon those fundamental principles we have erected our statutes of education, of morality, of religion, of temperance, of the public health, of charity, and no people that keeps its face turned toward these eternal truths can reach any other goal than that which all people know it were better to strive for.

Director Woods—Maine has been fortunate in its executives, not only in the Governor's chair, but in that which, since the establishment of the State Board of Agriculture, has had much

to do with our common people: first the Secretary and now the Commissioner of Agriculture.

We have not had a great many men who have occupied these positions, but they have been excellent men. Dr. Ezekiel Holmes, the first Secretary of the Board of Agriculture, acting at a time when work on boards was comparatively new throughout the land, laid out in clear and unmistakable manner what has led to success in that department. He was followed by Mr. Goodale and he in turn by the men still living who have and are still carrying forward in ever increasing efficiency the work so excellently begun.

We deem it very fortunate that we have at the present time as Commissioner of Agriculture, a man well fitted to harmonize the agriculture of the State so that there is no discord. With a voice that can be heard from Kittery to 'Quoddy and from Monhegan to Fort Kent he tells that we must work in harmony and that we must *work*.

I take pleasure in introducing to you Hon. A. W. Gilman, Commissioner of Agriculture.

Remarks by Hon. A. W. Gilman, Commissioner of Agriculture.

Mr. President, Ladies and Gentlemen:—It affords me great pleasure this afternoon to represent the State in the capacity that I do. The Experiment Station in its early days sometimes encountered very stormy seas. The average man, although he was fairly intelligent, had little faith in scientific or book farming; consequently the experiments that the Station was working out for the benefit of agriculture were received by the farmer with a great deal of doubt. I can remember very distinctly when the distinguished gentleman from New York who is to make the address this afternoon attended a farmers' institute in my section of the State, and was trying to demonstrate some scientific principles that the Experiment Station was discovering. These were so much at variance with the views of one of the leading farmers who had been fairly successful in stirring the soil without any knowledge of science as applied to agriculture that he vigorously opposed the new methods and severely denounced the Director of the Station and all book farming and declared that all such teachings were false. That was the way that the work of the Experiment Station was re-

ceived by the farmers in all sections of the State. The Station was persistent in presenting these new truths, and these were the first steps towards better things in agriculture.

The Experiment Station has done for Maine a great deal; it has accomplished much. When holding a farmers' institute in Aroostook County a short time ago, one of the large farmers there who had 120 acres under the plow, said to me: "The Experiment Station of this State has been worth more to the great industry of this country, potato culture, than the Station has cost from its original organization up to the present day." Today all of the intelligent farmers are guided largely by the information that they have gathered from the Experiment Station. The Government has spent millions of dollars in research and investigation and our Station has done as much of this work as any station in the country; and the agricultural people of Maine are directing their farm operations largely by the information that it has furnished.

Maine is the great agricultural section of the East. She has more good acres of tillable land today than all the rest of New England combined. What Maine needs is more intelligent agriculture.

It affords us great pleasure to consider just a moment the men who have been at the head of this Experiment Station. They are men of exceptionable ability. Dr. Jordan, a man of great energy and personal influence, devoted the best of his years to investigating the agricultural conditions of Maine. He possessed that rare tact and discrimination which made him a leader of men, and by his persistent energy and determination to instruct the farmers by personally meeting them in their own field and explaining the conditions and the character of their soils, he soon convinced them that the work of the Experiment Station was doing much to advance agriculture; and there has been an increasing interest among the farmers in the Experiment Station during the entire life of the Station. Dr. Jordan became such a distinguished investigator that the great State of New York offered him greater advantages than Maine could, and he has created for himself a national reputation and is second to none in his profession.

Dr. Woods than became Director of the Experiment Station and under his intelligent, careful guidance it has been doing a great work and the people of the State of Maine have always

accepted and adopted his work and today there is no experiment station in the country whose director the people have greater confidence in than the people of Maine have in Dr. Woods.

This Station has been worth more to Maine by being fortunate enough to have but two directors during its history, so that there have been but two policies or practically but one as Dr. Woods took up the work laid down by Dr. Jordan and carried it along with the same degree of success. One of the most gratifying things about this to the rural people and the farmers of Maine is the fact that these were both Maine boys. It has been said that Maine is a good State to emigrate from, but we believe that Maine is a pretty good State to stay in.

The farmers of the State stand by the Director of the Station; they are for him and with him, and that is a great thing. If you do not have confidence in your captain, what does it amount to? The State is doing more for agriculture than it ever did. You should have heard the State Dairy Instructor this morning plead for better agriculture and for union of efforts,—to get together to organize associations so that we might have the benefit of the whole interests of this State.

The legislatures of our State are never stingy along the line of agriculture. We have never asked for an appropriation that has not been willingly granted.

The dignity and respect of agriculture were never as fully admitted as now. The rural people have greater faith in the possibilities of this industry and our city cousins love to talk about it. By the aid of this Station and the united effort of all the agricultural forces of the State we predict for the new agriculture that Maine is to adopt, a more intelligent, profitable advance than she has ever known before.

Director Woods—The Experiment Station from its beginning has been fortunate in its board of control which we call the Station Council. I want to briefly refer to two members of the first Board of Control of this Station who have done very much for agriculture in Maine. The Hon. Z. A. Gilbert was at the time the Station was established the Secretary of the Board of Agriculture and he became a member of its Board of Control. Those of you who knew Mr. Gilbert in those days knew a constructive man who, after he had made up his mind, went

persistently through to the end. He was and is a writer in the State.

Another member of that Board has done in a quiet way perhaps more to influence agricultural thought in this State than any other man. He was also an editor and writer—a very prolific writer. Hon. Samuel L. Boardman is known to many of us here very likely by his connection in later years with the Bangor Daily Commercial. Mr. Boardman along agricultural lines is what one might term an idealist, and yet he was a careful, clear and luminous writer on subjects that had to do with practical agriculture.

I hoped that Mr. Gilbert would be with us today. Apparently for some reason he was disappointed, as only a few days ago he told me that he would be here, but we must remember that these people are not longer young and it is not easy for them to say where they will go and when they will go.

Mr. Boardman is at the present time spending the winter in New York so that it is impossible for him to be with us, but he has written me a personal letter, which with your permission I will now read.

Letter from Hon. Samuel L. Boardman.

My Dear Dr. Woods:

I am glad to know you are to observe in an appropriate and public manner, the passing of the quarter-centennial of the establishment of the Maine Experiment Station, and write to thank you for an invitation to be present. First of all, I wish to express my regret that it is impossible to accept your most generous invitation and to say it is far more important that you are to have with you men who were closely connected with its official establishment and with the first years of its work, a feature of most happy recognition in the day's program. I refer to Hon. Frederick Robie, then Governor of Maine, who signed the bill by which the act creating the Station became a law, who was, for a full decade of years, State Master of that influential organization, the order of Patrons of Husbandry; and to Dr. Whitman H. Jordan of New York, Director of the Maine Station for the first eleven years of its work—both of whom are to address you.

In general we do not give sufficient attention to the beginnings of things. In this day of invention and discovery, when

we are recording history so rapidly, when so many surprises constantly open to us in nearly all fields of science, thought and effort, we are so bewildered by real achievements which become actual and which we once thought impossible if we thought of them at all; that we forget the real inception and infancy of important matters in life after they have attained prominence and value, and after we realize we could not get along without them. The early history of many important subjects so quickly vanishes, that we should stop at all great days in the record, and make a reckoning of what has been accomplished while those who took part in them are with us to witness to their truth. As for the future, results of the present lead us to believe they will take care of themselves.

The occasion you observe is one of those great days, and it is well to recall the event that we may note the vast strides in our better farming methods within the quarter-century.

Although the act establishing the Experiment Station was not approved until 1885, it is significant that four years previous to this, in 1881, the State Board of Agriculture called attention to the necessity "for legal action in the control, inspection and sale of commercial fertilizers in order to protect our farmers against fraud in their use"; while in 1882, the Legislature being in session, the Board of Agriculture again recommended the establishment of an experiment station at the State College.

I speak of this action on the part of the State Board of Agriculture to show that it was that body of progressive men which was really the Board of highest authority and influence in advanced farming in our State. They were the foremost to take steps for improvement; the originators of new schemes for rural betterment; the first to aid whatsoever could make for a more profitable agriculture. Those men wrought better than they knew—for such work as they did then, would, in the light of today, be given prominence as of superior value, approved with greatest emphasis.

Just here I wish to say that I believe a state organization having an official connection with each county through a legally recognized member who is paid for his services is the only true society or board by which a system of public agriculture can be best administered. Such a man should be a representative farmer, widely acquainted with the physical features of his county. He should know the character of its soils; its im-

proved and its unimproved lands, capable of yielding profitable crops; its forests, trees and orchards; its waterpowers and industrial facilities of all kinds; its livestock and its markets; its agricultural, educational and social organizations; the work of the granges and of farmers' institutes; the particular line of agriculture for which the county is adapted, and the different agencies for the betterment of country communities in their relation to the life of rural residents as apart from those who live in cities and large towns. Such an organization should be above politics, for agriculture should not be a factor in politics. Its best development is a problem of the State and while I believe in every wise agency for its promotion I yet believe better and greater results would come from such an organization as is here outlined, than from any other body that has ever been given legal authority in this field, so far as I am acquainted with organized agencies for such work in our country.

Twenty-five years ago agriculture in Maine, looked at in the improved light of today, was somewhat primitive—at least when compared with the better and higher classes of work. It was more after the old order, for the new order had hardly been introduced. There was, moreover, much opposition to an experiment station, among farmers, as there was later, opposition to the introduction of the Australian Ballot Law among many light-weight politicians. While our farmers thought experiment stations would do for old world countries where farmers were ignorant and the soil had been cropped for centuries, we did not need them in the new world where our farmers read agricultural newspapers and knew all that was worth knowing about farming.

Yet opposition to the establishment of the station was no greater in Maine than in other States. Even in the great State of New York opposition to the Geneva Station was as decided as that to our own station at Orono. Dr. Jordan, in his address at the quarter-centennial of the New York station at Geneva, August 20, 1907, spoke of the opposition in that State, quoting what the New York Sun, then controlled by that great editor, Charles A. Dana, had said about it when its trustees went to the Legislature for aid in its work. This is the language which it used: "From top to bottom the station and its operations have been a fraud on our farmers and taxpayers. In the name of New York's insulted farmers, and in the name

of good government, we demand of the Legislature to abolish the Geneva Agricultural Experiment Station. It is a humbug." Yet the Geneva Station now lives and received from the Legislature in 1908, the sum of $89,500. Of this, $20,000 was for scientific research, $10,000 for fertilizer inspection, and $3,500 for the inspection of feeding stuffs. What do you know about this for a humbug?

Another source of opposition may be mentioned. The Maine Station was connected with the State College and the College was then young and with small influence. To be sure it had graduated its first class of thirteen, little more than a dozen years before, it had five or six college buildings including a laboratory in common use by college and station, but it was obliged to crawl upon its hands and knees to the Legislature to get a few thousand dollars a year for most urgent needs. The outbreak of pleuro-pneumonia in the college herd had made it necessary to destroy the animals, and the Legislature had been asked for an appropriation of $5,000 to repair the loss. There was a division in the public mind upon the wisdom of such action regarding the herd and in asking for an unusual appropriation, which did not add to the harmony of feeling in support of the station—if, indeed, it did not operate against it.

As this was but a year after the station had been organized and before it had shown any distinctive work, the station and the college both suffered from that public calamity. It led, however, to the enactment of better laws for protection to the livestock of the State from the introduction and spread of contagious diseases.

The State has been exceedingly fortunate in having as its chief staff-workers men born in Maine, known to our people, acquainted with our State and its agriculture, and educated for their work at our own State College, in other great educational institutions of New England and by post-graduate studies at foreign universities and experiment stations. The late Walter Balentine was its first acting Director. He was a graduate from our State College and afterwards had worked at other stations, studied in Germany and was connected with the station until his death in 1894. For the first eleven years of its work, Dr. W. H. Jordan was Director—a graduate of our State College and since 1896 Director of the New York Experiment Station, where he has done magnificent work and placed the

Geneva station among the foremost institutions of its kind in this country. The present Director returned to his native State to succeed Dr. Jordan in 1896, after having graduated at a leading university in another New England State and where he had already attained distinction in experiment station work. It may also be worthy of mention that two of the leading agricultural journals in the State did yeoman's service in making the real purpose and work of the station known to our farmers, and in allaying public opposition to it,—the editors of each journal having been appointed as members of the Station Council.

It is impossible, in the brief manner in which I am writing, to give particulars of the growth and work of the station during its earlier years, while it is unnecessary, as such work is known to the whole State and evidences of growth and vitality are all about you. From a laboratory and business offices loaned by the State College in 1885, to its present beautiful and commodious buildings—one of which bears an honored name—with their most serviceable equipment; and from a force of two or three clerks and special workers, in 1885, to a staff of twenty-five skilled and educated persons in a dozen departments of administration and science, in 1910—marks a degree of progress that is full of achievement and success. Such is the record of your station.

When it comes to results, however, those which show betterment in your agriculture cannot be given in so few words as I have just used. The departments of the station are now so well systematized that original investigation or research work is entirely distinct from that of special inspection required by law—the Director having charge of both divisions with a laboratory force assigned to each.

Time would fail me should I attempt an enumeration of the wise measures accomplished by the station for the everlasting good of Maine agriculture. Could I tell you about the improved practices and the judicious laws for which we are directly indebted to the station, it would fill a volume. Look you at the annual reports and special bulletins for twenty-five years, and see for yourselves.

The many methods of demonstration, the farm mixing of chemical fertilizers, the work of spraying, our better protection from injurious insects, management of the model farm in orcharding—too early yet for positive lessons but abundant of

promise for the future—together with solid laws, just and prudent in their terms of enforcement, regarding the inspection of agricultural seeds, commercial fertilizers, commercial feeds for farm stock, foods and drugs (laws which give protection against a system of adulteration and fraud that was becoming alarming) are too important to be passed unmentioned, or their value underestimated. The one lesson of the growth and spraying of potatoes as demonstrated by Director Woods in Aroostook, has been worth more to the farmers of that single county, in the cultivation of this crop alone, than the whole college and station have cost the State from their original establishment until now.

Could I stop with mention of a result more convincing or more overwhelming? And yet I must stop, expressing the hope that March 9, 1910, may be to you the best red-letter day of which you have had many in the quarter-century now closing, and of which I trust you may have many in the future.

I remain,

Most sincerely,

SAMUEL L. BOARDMAN.

Director Woods—When 25 years ago the legislature established the Maine Agricultural Experiment Station they gave it no home. The Maine State College instead of having chemical laboratories then had but a single laboratory. A board partition was built across that laboratory and the College shared its facilities with the new Station. And so commencing at that early beginning the Experiment Station has been closely associated with the Maine State College and then later with the University of Maine. We are very glad to have our home here on the campus and proud of the fact that we were a part of the State College which has become a great university and which will become greater and greater as the years go on.

We have been fortunate in a way in having only two directors to the Station, as it has made possible more united action than if there had been frequent changes in administration. Both the first director and the present director of the Station appreciate that in chemistry, which has been the leading line of work in the Station, we have been still more fortunate in that from the very organization of the Station down to the present time we

have had the same chemist. It is my great pleasure to introduce to you Mr. J. M. Bartlett, Chemist of the Maine Station for the twenty-five years it has existed.

Reminiscences of the Chemical Department.

James M. Bartlett.

When our chairman was making up the program for this occasion he said I would be expected to say something because I was the only member of the Station Staff who had been continuously connected with it since the Station was first established. When I asked what I should be expected to talk about he said that ten or fifteen minutes given to reminiscences of the chemical department would be sufficient. Now I fear that I cannot do the chemical department justice in that length of time, and if it seems to you when I have finished, I have not said much for this department, you must not assume that it has done but little, but that it has done entirely too much to be covered in that length of time.

Before speaking of the chemical department I want to say just a word about the thing that always impresses me most when I stop and look about, and that is, the marvelous change that has taken place in the appearance of the campus since the time the Station was started 25 years ago. Those of you who did not see the place at that time cannot realize how great this change has been. The only college buildings then, aside from a few residences, were Oak Hall, the Commons, White Hall, which occupied the present site of Wingate, Fernald Hall, and the wooden workshop in the rear. Very few of the trees that now adorn the grounds were high enough to show above the snow in winter and many of them were not planted. Along the street leading to the village of Orono there were no trees higher than a man's head and no residences between Orono and the Mt. Vernon house. There were no electric cars, and the only public conveyance was Uncle Ben's bus, which together with its genial owner will always be remembered by the older graduates as a part of college life.

For reminiscences of the chemical department I have made a few brief notes. After receiving my appointment as assistant chemist in the Maine Experiment Station, I came to Orono about May 1, 1885. Professor Balentine at that time was act-

ing director, Professor Jordan not arriving until about July 1. We began the first chemical work in a corner room in Fernald Hall, now occupied by the professor of pharmacy but at that time the office and private laboratory of Professor Balentine. In this room we analyzed about 50 samples of fertilizers, representing 28 different brands, and this covered the chemical work of inspection for that season. Through the generosity of Professor Aubert space was allotted us in the main laboratory and a room 15 feet wide running the whole width of the building, was partitioned off during the summer vacation of the college. This was used as the chemical laboratory of the Station for about two and one-half years. We moved into this room late in the summer and were kept busy during the fall and winter, making many analyses of fodders, feeds, etc., used in connection with feeding and digestion experiments started by the director.

It no doubt was fortunate that we were busy, or I fear that we should have been homesick; for at that time the long vacation of the college came in winter and the campus looked deserted and desolate during the winter months. The thing that I recall most vividly about the first winter at Orono is the great snow storm, one of the largest ever known, I think, in this part of the State, which so effectively blocked the railroads that no western mail got through to Orono for five days. Travel in the streets was practically suspended and had it not been for the introduction of the Norwegian mode of winter travel, on skis, at about this time, I fear the Station would have been closed for several days. As it was, the Station force consisting of the Director and Chemist made their way across the fields from the village to the college building on those useful but somewhat treacherous snowshoes. At the beginning of the second year the chemical work had so much increased that a second assistant in the person of Mr. L. H. Merrill was appointed. The next year, 1887, was the banner year for all stations when the National Government passed a bill giving each state $15,000 to establish an experiment station. With this great increase of funds, more room was necessary not only for the chemical department but for other departments which were soon established. Therefore, the trustees very readily consented to construct a building which is the core or middle portion of the building we now occupy. Late in the fall our

Station building was completed and we moved into what we considered a very well equipped and convenient chemical laboratory. From this time on till 1895, nearly all the chemical work was done by Mr. Merrill and myself in two rooms of this building. In 1895 the Station made some dietary studies in co-operation with the United States Department of Agriculture, and an assistant chemist was secured to do this work.

In 1896 good fortune befell our director and he was called to take a like position in one of the largest stations in the country. This call we considered a great compliment not only to the man but to the Station and to the State as well; but, of course, we felt the loss most keenly of one with whom we had been closely associated for so many years not only in our work but outings also, and it seemed as though the Station which had attained such a good standing under his guidance must also feel the loss. The trustees, however, in filling the position made vacant by Professor Jordan's going, were extremely fortunate in selecting a man whose training and ideas of what a Station should be coincided so well with those of his predecessor, consequently the work went on almost without interruption. With the coming of Prof. Woods considerable more food of man work was added which necessitated the appointment of two assistant chemists.

Since that time the chemical force has varied somewhat with the amount of work there was to do, but at no time has there been less than four and sometimes as many as seven men in the laboratories.

In 1889 a fine new office for the Director and a chemical laboratory for the food work was added to our building. As time has gone on the chemical work required on account of the inspections has greatly increased; not only has the fertilizer work increased about four-fold, but two new inspections, feeds and food and drugs, have been added. Upward of 600 samples of feeds and 800 to 1,000 samples of food and drug materials are examined each year. We have now four well equipped chemical laboratories, any one of which is larger than the one we first occupied in Fernald Hall. The work of the chemical department aside from the inspections has been largely along the line of plant and animal nutrition investigations. Some of this work has been planned and carried out by the department itself, but considerable of it has been done in conjunction with

other departments. This work, particularly the digestion experiments, involved a large amount of chemical analyses and some years occupied a large part of the time of the chemists. The time allotted me does not permit of any more than this passing mention of it.

Of late years the time of the chemical department has been diverted more and more from lines of investigation to inspections and control work. With the present force and means this seems to be a necessity, but it does not signify that we think there are no more chemical problems in agriculture to be investigated or a place for chemistry in scientific agriculture. On the other hand, we do most sincerely believe there is no other one science so closely associated with it. We believe that a good knowledge of chemistry is essential to the professional agriculturist. For instance, the agronomist encounters so many problems in the handling of soils, manures, fertilizers, feeds, etc., that involve a knowledge of chemical relations, that a good chemical course is the best foundation for success in this profession.

Bacteria just at the present time are attracting much attention in the problem of plant nutrition, but the changes brought about by these little organisms are largely chemical changes and they are really microscopic chemists working in nature's laboratory. Therefore, the bacteriologist should have a good chemical knowledge in order to understand the work of his little assistants.

The economic entomologist is dependent on chemistry for his insecticides, the plant pathologist for his fungicides and culture solutions, and the biologist for his antiseptics and anæsthetics. We do now and have always believed, in a chemical training for what we consider the highest position in the agricultural profession, that of an experiment station director, and to substantiate this claim we can cite some of the most successful directors in this country and Europe who were trained as chemists.

Director Woods—I said that 35 years ago the first agricultural experiment station in America was established in Connecticut. It so happened that it, as in the case of the Maine station, was dependent upon the charities of a college for a home. And it also so happened that I entered that college as a freshman and began to hear about the experiments and about the men who were working in the Connecticut Experiment Sta-

tion. Among them was one that came later to be professor of agriculture here and was for the first three months the Director of this Station. Professor Walter Balentine was a man who contributed enormously to the Maine agriculture the short time that he was here. It is one of those things hard to understand and well nigh impossible to accept that in the accidents of life a man like Walter Balentine is taken out of the activities when he has just begun to labor in a field where he was greatly needed. And so for a moment I would like for us to stop and pay a passing tribute to this man who in those first days, before the director of the Station could arrive, acted as its director.

Two years later, when I was a Junior, there came to that Connecticut College to assist in the work begun in that first American Experiment Station, a young chemist with whom I was associated in work for the year. The friendship then formed has strengthened as the years have gone on. Having something of a common training and many ideas alike, it was possible when I came here to succeed him, to follow the lines that he had so thoroughly blocked out.

No graduate of this College has contributed more to its honor, to its success, or has given more luster to its name than the first director of this Station. I told him when I met him in Boston last week that he could never understand how gratified I was when I received his letter saying that he could come to give this address. I would hardly know where to have turned for a man equal to the occasion if we could not have had Doctor Jordan.

It is with great pleasure that I introduce Dr. W. H. Jordan, the best known alumnus of this University, the first director of this Station and the present director of the New York State Agricultural Experiment Station.

Conditions Which Limit Agricultural Efficiency.

Whitman Howard Jordan, Sc. D.

This occasion is one that appeals strongly to my sense of personal relationship. The real gratification that I experience in participating in this event, to which I frankly confess, has its source very largely, I am sure, in past associations. I cannot forget, I would be ashamed to forget, that this is my native

State, and this, my Alma Mater. It is not mere sentiment to declare that he who is not conscious of an abiding kinship with that land on whose soil eight generations of ancestors have lived during more than two and a half centuries, has lost a precious birthright, and is an Ishmaelite indeed. Nor is he less degenerate who forgets his indebtedness to that institution where he attained a larger vision of life and its possibilities.

I am also moved by the thought that at this time, when we celebrate a recognized achievement, I am permitted to meet with friends, who labored with prophetic zeal during years of severe trial and discouragement in the organization and development of new agencies that now occupy a conspicuous place in conserving and promoting our national well being. Those of you who have confronted popular misunderstanding, beseeched legislatures and campaigned the State, in the interests of a more enlightened agriculture, may be pardoned a feeling of exultation, now that even the great universities of the land are eagerly announcing their devotion to the cause of agricultural education, and the captains of industry are insisting that the preservation of our national strength must be accomplished through a widespread education of the rural people in the facts and principles of a rational farm practice. It is not too much to claim that a readjustment of educational means and methods, the essentials of which were embodied in the Morrill Act of 1862, has been slowly but surely preparing the people of this nation to understand, and effectively meet, the great conservation problems that are now forced on us through the profligate waste of our vast resources of soil, forest and minerals. It seems to me that Dr. Fernald and those who were his co-workers more than forty years ago in initiating an epoch-making type of education should now regard with much satisfaction the fruit of their labors.

But our interest today is in a single institution and a single state rather than in questions of national scope. It is twenty-five years ago last Thursday since Governor Robie signed the act that created the Maine Fertilizer Control and Agricultural Experiment Station. I had the honor, as you know, to be the first director of the station, the fourteenth of its kind to be established in the United States. My connection with the institution, which covered a period of eleven years, was initiated by a telegram received by me at State College, Pennsylvania, in

March, 1885, from Hon. S. L. Boardman, announcing that the station was to be organized and asking if I would become its director. I quickly concluded to accept the offer, a decision that I have never regretted. Because I could not at once leave my duties at the Pennsylvania State College, Prof. Walter Balentine consented to become Acting Director of the station for three months, a position which he could not have filled more faithfully and successfully had he expected to permanently assume the directorship of the institution. When I reached Orono late in June Prof. Balentine transferred the work to me in excellent condition and placed at my service wise and helpful counsel that proved so valuable to me during the years, all too few, that I was permitted to have him as an associate.

Although I was the first director of the station I was not the first active and permanent member of its staff. Mr. James M. Bartlett, who was associated with me in chemical work at the Pennsylvania State College, was elected Assistant Chemist to the Maine Station in April, 1885, and at once left Pennsylvania to take up his new duties, and during the entire existence of the station he has been a faithful and efficient member of its staff. The only time at which I knew him to be in danger of losing his position was a few strenuous moments following his persistent attempt to administer a wash bottle baptism to President Gilbert and Dr. Fernald when they were vainly trying to repel his purpose and pay an official visit to the station laboratory. If you ask him about the event doubtless he will be able to recall it. During the first year of the station's life two other members were added to its staff, Prof. L. H. Merrill and Prof. Gilbert A. Gowell, both of whom served the institution for a long period.

Those of you who know the Maine Experiment Station only as it now exists with its generous maintenance fund, its able staff, its varied activities and its established influence in many directions, can have little realization of the circumstances that attended its formation and early efforts. I want to present to you as best I can a picture of the station as I knew it in its infancy. That was a day of small things. The Board of Managers was small in number, being composed of only five members, but when I name those men, Prof. Walter Balentine, Hon. Z. A. Gilbert, Hon. S. L. Boardman, William Downs and Benjamin F. Pease, you will see that it was not small in courage,

or in its purpose to make efficient the institution placed in its charge.

As evidence of the loyalty of purpose of this first station board I may refer to the fact that nearly all the samples of fertilizers analyzed by the station in the spring of 1885 were collected in various part of the State by Prof. Balentine, Acting Director of the station, and Mr. Gilbert, President of the Board of Managers. Whoever has done this disagreeable work can realize that these men who were connected with large affairs were making a great personal sacrifice in order to promptly and effectively accomplish the ends for which the station was organized. The spirit of economy in which this was done is shown by the fact that it cost only $37.82 to collect thirty-four samples taken at points all the way from Presque Isle to Portland, a refreshing example of economical public service which I trust is not yet considered as old-fashioned in this State.

But if the Board was small it was numerically on a par with the fund which it had to expend. I suppose the Maine legislature considered that it took long chances in turning over annually to the new institution as much as five thousand dollars, and was induced to do so, I fancy, largely by keeping to to front the argument of the commercial advantages of inspecting various commodities rather than the value of scientific inquiry. We have been slow to see that a body of well founded knowledge is our most valuable agricultural asset. With so small a fund you can easily understand that at first the station was not a very pretentious affair either in the space it occupied or in its equipment. My office, and the only office, was Room No. 7 in White Hall, that first college building, well remembered by the older students, that subsequently disappeared in smoke and ashes, a fate that it would have met earlier had not I one day extinguished a blaze in Prof. Hamlin's class room caused by his thoughtfully depositing a wooden model close behind a rampant sheet iron stove. In this office I was my own stenographer, clerk, bookkeeper and editor, but how my salary was divided between my several functions was never determined. I do remember that it did not impress me as large enough for a composite salary. The station chemical laboratory was a room in the east end of the college laboratory partitioned off from the space occupied by students. In this room, what time we were not in the basement wrestling with Prof. Aubert's

gas machine, the director and his staff of one or two men were fellow workers in whatever chemical analyses were performed. Surely it was a day of small beginnings when we all served in any capacity that the furtherance of our work demanded, whether with the workman's tool or with the crucible and balance.

But the station under its original form of organization had a brief life of less than three years, for on October 1, 1887, it passed out of existence and early in 1888 was reorganized on a broader and more liberal basis as a department of the Maine State College. During this preliminry period we had a diminutive staff and limited resources. Because the station came into existence during the adolescent period of station development in this country, and with a staff handicapped by both physical and official adolescence, it would be too much to say that our efforts produced a marked effect in Maine agriculture, but we worked earnestly and followed the best light we had. In the first two years, we published three very modest reports and twenty still more unpretentious newspaper bulletins. A few days ago I explored my library and found copies of these documents, some of which I have brought to show you. I shall not forget the remark made by the President of the Board at the close of its final meeting. As we rose to leave the room, Mr. Gilbert said, "We have the satisfaction of knowing that we have expended every dollar of the State's money honestly and for the purposes for which it was appropriated."

In March, 1887, a long hoped for event occurred which was the passage by Congress of the Hatch Act, appropriating annually $15,000 of federal money to each state and territory for the purpose of maintaining an agricultural experiment station. I do not know how other station directors were affected, but I was exultant, boisterously so. I saw ahead days of peace and plenty, devoid of the annual period of anxiety when a new and often skeptical legislature must be labored with to secure the continuance of a necessary maintenance appropriation. The stability of the federal aid to state stations, without effort on the part of individual institutions, is a proper cause for devout thankfulness. It is most irrational, indeed it is most unfortunate, when the head of a state educational or scientific institution, because of a periodical legislative campaign, is compelled to endure great anxiety and a drain upon his energies

that should be wholly expended in other directions. If an institution is worth maintaining at all it is worth placing on a permanent and definite basis that admits of the operation of continuous and uninterrupted plans. In several states, college presidents and station directors have been criticised for frequenting the halls of legislation, but their critics do not realize how dependent upon such activities of these officials have been the development and progress of agricultural education and research. These public servants have done this work because a system of annual or biennial appropriations have rendered it necessary, and in many cases, because no one else would or could do it.

The Hatch fund became available early in 1888 and with it came a new station building, an enlarged staff and broader activities. From that time the station has made steady progress, I believe, in efficiency and in its helpful relation to Maine agriculture. It is safe to say that all phases of agricultural production in this State are handled more intelligently because the station has existed. I congratulate my long-time friend, its director, and his staff, upon their achievements. I will not further ask your attention to the detailed history of the station and its work but will pass to the consideration of my subject as announced.

"THE CONDITIONS THAT LIMIT AGRICULTURAL EFFICIENCY."

In discussing this subject I shall deal with it largely in its relations to the State of Maine. What, then, can we say of Maine as a field for the operation of those agencies, educational or otherwise, that make for the betterment of its rural people? But before we consider Maine agriculture specifically, and especially before we discuss the factors that for the future will determine agricultural efficiency, we should bring to mind certain great economic and social changes that have produced a marked effect in the entire group of eastern states.

New England agriculture and the farm home are profoundly different from what they were a few decades ago. Up to 1850 and later the agriculture of the eastern states was very general in its character and included a great variety of products that were needed for home consumption and to satisfy the varied needs of nearby markets. General farming was the order of

the day. But just previous to the Civil War and during several decades following it, there occurred in our western country the most rapid and extensive opening up of new lands for agricultural purposes that civilization ever witnessed. In half a century the center of our population and of our improved farm land moved from West Virginia to the middle west. Rapidly developing railroads, two hundred thousand miles being built between 1850 and 1900, not only carried settlers to the prairies but transported their vast output of corn, wheat and cattle to eastern markets.

Accompanying this enormous expansion of our productive areas and indeed as an essential part of it came the development of labor-saving machinery which either destroyed or greatly minimized the industrial activities of the farm home and small village and centralized manufacturing, even of agricultural commodities, in factories mostly located in the centers of population. The spinning wheel, the loom, the churn and the cheese vat have disappeared from the farm home, and the shoemaker, the tin knocker and the grist mill are no longer found in the small village. Home-raised flour, home-spun jackets, linsey-woolsey dresses and boots from the nearby cobbler no longer have much place in the economies of the rural family. In short, the farm has lost much of its economic independence and now must resort largely to an exchange of commodities for meeting its increasingly varied needs.

Another modifying clause has operated in New England from the day the first new land was cleared up to the present time. Just as ignorance, indifference or unscrupulous greed have devastated the nation's wealth of waterpower, forests and minerals, so many farmers, blind to their own interests and unmoved by their obligations to promote human welfare, or else mentally unequal to sound agricultural practice, have been profligate of the fertility of their soil. The settled portions of New England present a varied panorama of depleted farms scattered among those that are still prosperous, a condition that is intensified by the practical abandonment of rugged area which under existing conditions no longer furnish a margin of profit from tillage.

We must also reckon with the ideals that have prevailed around the firesides of New England farm homes, for even there industrial and commercial conquest and professional suc-

cess have been exalted, and the imagination of the farmer boy has been fired with visions of power and eminence in the midst of the great world beyond.

The several economic changes I have enumerated, assisted by the unequal contest in legislative halls and in commerce between unsyndicated agriculture and syndicated industrial interests, have caused certain far-reaching results. New England and Middle State farmers could not meet western competition and during the last decades of the nineteenth century they suffered serious business hardships because they were unable to at once abandon old lines of production and enter upon new enterprises that were profitable. This immense expansion of our cultivated lands and the competition that rapid and cheap transportation has made possible between widely separated points not only depressed eastern agriculture but caused a readjustment of the areas of particular farm products according to special soil and climate adaptations and business opportunity. New England must now produce that with which the west can least successfully compete.

Again in the twenty years between 1880 and 1900 the open country of the eastern states became seriously depopulated. During this period the population of New York, the state in which I live, diminished 730,000 in places of less than 4,000 persons, and in Maine the decrease was more than 70,000 over 10% of all her people. This result, due to a depressed eastern agriculture, the attraction of western homesteads, the centralization of industrial life in the cities, and the commercial spirit that has seized us, was inevitable. It was merely a distribution of population on the basis of opportunity, and no amount of sentiment, or philosophy or education, could have stopped it or very much modified it. A great deal has been written during the past few decades about keeping the boys from leaving the farm, and various causes for this desertion of the soil have been assigned. Appeals have been made to fathers and mothers, to the schools and to the college of agriculture to cure this agricultural unregeneracy on the part of farm boys and girls, but nothing could have neutralized the powerful influence of a widespread readjustment of business and the young men and women went where conditions forced them to go, in fact where many of them were needed.

And here I take the opportunity of saying what should in all justice be said in defense of the early workers in this college of agriculture. During the first thirty years of the life of this institution the boys who entered here, in the exercise of their inalienable right of choice, had a perverse way of electing to study engineering in some of its phases rather than agriculture. Because this was so, various persons from the platform and in the press, being possessed of a degree of ignorance that is essential to severe and unmodified criticism, declared that the fault was with the administration of the college, that its faculty was not in sympathy with agriculture and deliberately led the young minds under its care into the by and forbidden paths of engineering and the studies that had always been a part of the older curricula.

Those of you who are familiar with the history of those earlier days know that this criticism was not just. You know that *bona-fide* agricultural students were enthusiastically welcomed as an oasis in a desert of engineering proclivity and were given all the opportunities that the means and the equipment of the college afforded, because the presence of such students was the surest way of convincing the public that the institution was fulfilling its real function. I assert that no men have ever espoused the cause of agricultural education who were more loyal or zealous in the performance of their duty than were those pioneers in a work beset with inexperience, crude pedagogical tools, public prejudice and untoward economic conditions. I give all honor to the teachers of today with their class rooms full of students of agriculture, but I want them, with humble minds, to remember that in educational means and methods they have entered into the fruit of other men's labors, that the tide of economic affairs is in their favor and that had they begun their work forty years ago they would be fighting a battle instead of enjoying a victory. In those earlier days, the college of agriculture and the business of agriculture were in the grip of powerful and far-reaching influences that neither could nullify, and the depopulation of the farms and the lack of population in the agricultural class rooms, were due to the same general causes. Let us rejoice that a new day is here with a returning tide of interest in the land.

But I have digressed from my theme. I return to it to say that the most serious result of the conditions I have outlined has

been the depression of the social life of the rural people, perhaps less marked in Maine than in some other states partly because of the dominant influence of the grange. But that this depression is a fact to be reckoned with in at least portions of New England no student of rural life doubts. The rural church, while feeling the effect of the departure of ecclesiastical authority and of a marked change in religious thought, in the decline of its vigor and influence may be taken as an expression of a general change. We cannot deny the fact that a half-century ago, before the days of rapid communication, the isolation of the small but widely distributed centers of rural population was favorable to the maintenance of home enterprises and of such social activities as were adapted to country life. The attention of the people was concentrated upon home institutions into which flowed the industrial and social energies of the surrounding community. Now rural life is more or less drained of its social energy, for both commercially and in matters of human interest its attention is fixed upon those centers of population to which it has come to sustain a more or less suburban relation. We now need a redirected rural life that socially centers upon itself. I am one of those who hold that the degree of success attained in the development and maintenance of an elevated and attractive human environment for the farm home will more fully determine the future of American agriculture than will the spread of vocational knowledge.

When we come to consider Maine alone, it cannot be said that she has escaped the influences of the changes I have outlined. Nevertheless her present status is most encouraging. First of all, notwithstanding its age, Maine is still an agricultural state, and in this respect compares very favorably even with those great farming states of the middle west which New England helped to settle. In 1900, 63.8 per cent of her population was classified as rural while the figures for other states were, Ohio, 55.2 per cent, Illinois 49 per cent, Iowa 79.5 per cent, Michigan 62.8 per cent and Wisconsin 65.5 per cent. These figures mean that, like certain great agricultural states, the majority of your population is dependent upon the soil for a livelihood.

In one most important particular Maine stands pre-eminent among all her sister states. The census of 1900 showed that 93.8 per cent of her farms were tilled by their owners, and that the same percentage of farmers owned farms, figures equalled

by no other state. The rental system has secured little hold on Maine agriculture, a fact of great significance as regards the character of her rural population both now and in the future, even if the individual farms are small. It is the permanently established families, devoid of the itinerant habits of the renting farmer, that give stability and character to our rural population. It is the man who tills his own farm who is likely to dignify his citizenship by an active and intelligent interest in the affairs of his community and his state. It is the family hearthstone, sacred to the memory of many generations, that inspires us with love of home institutions. This good state will possess agricultural strength as long as its farm homes rest amidst their own unencumbered acres.

I think it is not flattery, but only a just estimate to say also that Maine possesses a comparatively high grade farm people. This assertion may not be susceptible of exact demonstration, but I regard as convincing proof of the accuracy of this statement the remarkable number of successful business and professional men all over our land who are the product of Maine homes. Such men are not the children of intellectually and morally inferior parents. With the situation that now prevails and with agricultural and business conditions rapidly becoming more favorable to farming in the North Atlantic states, you have every stimulus for abandoning depletive methods and entering more fully into a constructive agricultural policy.

This policy must be as broad as are the needs of agriculture, both vocational and social, and should be directed to certain general ends among which the following seem to be important:

(1) If the waste of our soil resources is to be stopped and agriculture enter upon the policy of reconstruction, farm practice must be brought more fully under the direction of scientific methods.

(2) The day has come when this state must increasingly develop a specialized agriculture that takes account of soil, climate and business adaptations. There is no better sweet corn, potatoes, dairy products or apples than are produced in Maine. In some directions you are doing well, but you can do much better. I know of no more striking example of a shortsighted policy, or rather lack of policy, than your largely undeveloped possibilities of apple culture.

(3) The broad business relations that agriculture sustains, and which may be so profoundly modified by organization and legislation, both state and national, point to the need of educating farmers to an intelligent community of action directed toward well defined and carefully considered ends. This requires on the part of the individual wide vision and a broad-minded appreciation of the conditions essential to business success. The intensely individualistic and unassimilable farmer is not in adjustment with his day and generation.

(4) The social consciousness of the rural people should be more fully aroused and directed to higher social aims, to the end that country life institutions may be re-established.

I shall not attempt to discuss in detail how these results are to be reached but shall try to point out rather certain considerations fundamental to the work of the college and station. All our efforts to promote agricultural efficiency, if they are to amount to anything, must focus on the individual. It is a fundamental truth, indeed it is axiomatic, that the art of agriculture and the returns to the farm both materially and socially, will never rise higher than the level of the men who own and manage the land. No other class and no outside forces or devices can impose prosperity upon the farmer. The initiative is with him. If he wishes for better conditions for himself and his family they must proceed largely out of his own efforts. Neither the college of agriculture and its experiment station, nor any other agency can lift him over certain obstacles to success. It is a question of personal acquirement and endeavor. The remark is current that the only way to redeem or build up agriculture is to make it more profitable. What agency is it that will make agriculture more profitable? Will government, will laws, will institutions, will propaganda? These may stimulate action, may even create opportunity, but you must have men that will respond to stimulus and that are capable of entering into opportunity. The great paternalistic agencies of government will serve their highest purpose, not in mere gratuitous help to farmers which may breed a wrong attitude on their part, but rather in arousing personal initiative and endeavor. This means that educational efforts of some kind or other will be our chief dependence in accomplishing agricultural betterment whether we seek a more intelligent farm practice, more favorable social conditions or juster laws.

And a great educational movement is here, one that is rapidly enlarging. It embraces in its sweep the university, the school, the church, the grange, agricultural organizations and even the railroad train, whose efforts include the college class room, short winter courses, farmers' institutes, convention meetings, station bulletins, extension literature, demonstration farms,—in fact an almost bewildering variety of activity. The significant fact, the fact that should arrest our attention just now, is that this effort is very largely of a popular character, the distribution of highly diluted information. Not only is this information greatly attenuated but taken as a whole it presents an unspeakable confusion of sound knowledge and unwarranted inference and opinion. Much of its is exploited in the name of science but has no scientific justification. There are some self-ordained priests of science who teach strange doctrines. This kind of endeavor is absorbing much energy on the part of the college of agriculture, and to some extent, of the experiment station.

Now these institutions are fixed and permanent agencies. They are here to stay, with an enlarging influence and usefulness as time goes on. It is important to inquire, therefore, what is their true and most useful function, whether the almost resistless tide of popular agricultural propaganda is to carry them too far away from certain essential functions in promoting agricultural betterment which only they can exercise. I say this because there is, and always has been, more or less confusion in the public mind concerning what the college and station should be expected to do, and the experiment station especially has been coerced into efforts that do not belong to it. I am inclined to think that Maine has largely escaped this misapplication of its station's activities, and if so, it is a matter for congratulation. Do not abandon your wise attitude.

Every department of human endeavor, agriculture no less than any other, needs as a basis of safe practice a body of well grounded knowledge. The greatest and the most permanent acquisitions that have come to agriculture as an art during the past fifty years are the outcome of profound scientific studies and our future success in conserving and developing the fundamental resources of this nation will depend largely upon our increased mastery, through increased knowledge, of the matter and energy of the physical work. Knowledge is a limiting factor in all human endeavor. It is the function of the station to

acquire knowledge agriculturally important rather than distribute. The station is not a teaching agency either in the academic or popular field. If the investigator is not to be defended in the continuous and uninterrupted use of his time in the study of problems, but is to be submerged by the demands of a popular educational campaign, as is the tendency in some states, his value in the field of research will be practically destroyed. His appearances at farmers' institutes, grange meetings and other popular gatherings should be judiciously limited. The farmer has a wrong point of view when, as is so often the case, he measures the value of a member of a station staff by the frequenecy and success of his platform appearances. Such an estimate is a failure to understand that agricultural practice has no greater need today than an enlarged vision through more and safer knowledge, and that a new truth may have vastly greater value than many volumes of pleasing addresses.

There is no less reason for solicitude concerning the work of the agricultural college. Some days ago I took part in a conference of a few men, four of whom have developed with notable success the agricultural colleges of departments under their care, and they were of one opinion concerning the critical need in the existing agricultural situation, viz., that it is an adequate supply of well trained investigators, teachers and leaders. The fact is, experiment stations are inadequately supplied with men competent to enter the field of inquiry, the number of college teachers who have made a notable success in the agricultural class room is surprisingly small and the supply of trained and well equipped minds available for service in carrying on the widespread efforts of popular education is much below the demand. These are fundamental weaknesses.

The relations between sound learning and the farm are not unusual or peculiar. It is as essential to agriculture as to any other vocation, that its activities shall be related to centers of intellectual stimulus and acquirement, where studious minds shall deal with truth under well organized and searching academic methods, and where students shall be trained to be safe and conservative exponents of agricultural science. The shifty vaporings of mere opinion are just as dangerous to agriculture as they would be to the practice of engineering. Moreover, the man destined for leadership in agriculture should be broadly equipped. Narrow technical training that ignores human rela-

tions is not adequate to meet the economic and social problems now involved in agricultural betterment. Mere vocational efficiency never has become the measure of a broadly useful man or of a strong community, and never will. Do not think that I deprecate the popular educational efforts that have proved so useful in this and other states. I would not have less of them but I would have them rest more fully on a substratum of sound knowledge and safe thinking, which it is the function of the college to build. The investigator in his laboratory and the teacher in his class room may receive less of popular appreciation and approval than those workers who meet the public, but they may rest content in the assurance that their labors are supremely important.

I am confident that these functions of the experiment station and the college, the importance of which I have been trying to set forth, will be magnified as time goes on. We are coming to see, with surprising tardiness, to be sure, that the college is but a single factor in a great agricultural movement and that it does not occupy the whole field of agricultural education, and cannot do so. The needs of a majority of our youth must be met by other agencies. Notwithstanding their great usefulness, these agencies must be something else than the farmer's institute and agricultural press whose discussions are too conflicting and partake too largely of mere personal opinion to effectively diffuse a body of well organized knowledge. The secondary school, whether the academy or high school, and even the grades below these, must be readjusted to a type of instruction more effective in meeting present day demands before we shall establish a widespread, systematic and well scrutinized knowledge of the environment of farm life. Some day we shall remove from off the face of the earth the apology for a schoolhouse that now stands in every township and substitute space and materials for instruction in the realities of human life and activity, and we shall train teachers to utilize these facilities. When these things are done for the schools, when educational work of the more popular kind becomes organized so as not to divert the energies of the investigator and the college teacher, then we shall have a division of effort among several agencies that will make for the higher efficiency of them all.

Do not think that I would have college divorced from the effort of extending knowledge in a popular way. Indeed, I regard it as wise that extension teaching is being placed more and more under the direction of the agricultural colleges, because there is coming rapidly a profound change in the means and methods of such teaching. The old farmer's institute, that useful agency that has been the arena of much speaking and little real demonstration, is bound to pass away and the day of object lesson instruction is coming, a method that requires the services of technically trained men. Over twenty agricultural colleges have established extension teaching departments, or their equivalent, and if the bill now before Congress becomes a law the object of which is to aid the colleges by federal appropriations to enlarge their extension work, such teaching will undoubtedly pass into the hands of college departments organized for that purpose.

But we should make no apologies for the past. The means and methods of agricultural education are being developed through experience that is inevitably attended by mistakes. Nevertheless, since our crude beginnings a half century ago we have attained an epoch-making success that is exercising a profound influence on the policy of all educational institutions from the primary school to the university. We shall be wise if in all the readjustments through which we are passing, we hold fast to the one ideal that has exalted all education worthy of the name, the cultivation and perpetuation of those attributes of human character that are the most precious fruit of a Christian civilization and are the ultimate defence of all our interests both material and social.

Brief Historical Sketch of the Maine Agricultural Experiment Station.

The Legislature of 1885 enacted a law establishing the Maine Fertilizer Control and Agricultural Experiment Station. The purpose of the Station as defined in Section 1 of the act was as follows: "That for the purpose of protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds, and for the purpose of promoting agriculture by scientific investigation and experiment, the Maine Fertilizer Control and Agricultural Experiment Station is hereby established in connection with the State College of Agriculture and Mechanic Arts." The act was approved by the Governor March 3, 1885, and early in April the Station was organized with a director, who was also chemist, an assistant chemist, and an assistant in field and feeding experiments.

It depended for its quarters upon the hospitality of the Maine State College. A chemical laboratory for the Station was partitioned off from the Maine College laboratory and supplied with apparatus. Part of the dairy room of the College was fitted up with apparatus for use in experiments involving the handling of milk. A part of the new barn just erected by the College was turned over to the Experiment Station for feeding experiments and was fitted up with stalls, scales, etc. Field experiments were started by laying off about three acres of land into blocks, and box experiments for growing plants were also begun.

While the principal object of the establishment of this Station was the maintenance of a fertilizer control, in the first months of existence lines of investigation were entered upon, many of which have been continuously followed by this Station.

The Maine Fertilizer Control and Agricultural Experiment Station existed about two and a half years and issued 26 bulletins and 3 reports, the former being published only in the leading papers of the State and the latter as a part of the report of the Maine Board of Agriculture. Upon the passage by Congress of what is known as the Hatch Act, establishing agricultural experiment stations in every state, the Legislature of 1887 repealed the law of March 3, 1885, by an act which took effect October 1, 1887. It was expected at the time this act was passed, that by October first a station would be in operation under the provisions of the national law. This did not

prove to be the case, owing to the failure of Congress to appropriate money, and had not the College assumed the risk of advancing the funds to pay the expenses of the Station, work would have ceased on the date in which the old station law stood repealed. As it was, work was continued until January, 1888, when the station force disbanded to await the action of Congress. It was not until after the passage of the deficiency bill early in February, 1888, the funds became available for the payment of the expenses of the year 1887-1888. Prior to this, the Maine Legislature of 1887 had accepted the provisions of the Hatch Act on the part of the State, and at the meeting of the College Trustees in June, 1887, the present Station was organized as a department of the College by the election of a director and two other members of the staff of officers.

At a meeting of the trustees, held February 16, 1888, a general plan for carrying out the provisions of the Hatch Act, involving the expenditure of $15,000 per annum, was presented to the Board of Trustees and was accepted by them, and the development and management of the Station under this plan was placed in the charge of a Station Council, made up of the President of the College, the Director of the Station, the heads of the various departments of the Station, three members of the Trustees and a representative from each of the State agriculture organizations.

The Station Council meets once a year. At this meeting, the Director and other members of the station staff outline the work which has been undertaken in the past year and make recommendations for the following year. Such of these as commend themselves to the Station Council as well as suggestions from that body are approved and the Director is instructed to carry them out in detail. The appointment of members of the staff is made by the Trustees, and the recommendations of the Council are subject to their approval.

The Director is the executive officer of the Station and passes upon all matters of business. The members of the staff have charge of the lines of work which naturally come under their departments.

The Station has published 25 Annual Reports, aggregating 5500 pages, over 200 bulletins ranging from a single page to 75 pages or more, and nearly 400 miscellaneous publications, chiefly circulars of information. Space will not permit an enumeration of the lines of work undertaken and reported.

Station Council—1885-1910.

OFFICERS.

Presidents.

Z. A. Gilbert, 1885-1887.
Merritt C. Fernald, 1888-1892.
Abram W. Harris, 1893-1901.
George E. Fellows, 1902-

Secretaries.

Samuel L. Bordman, 1885-1887.
Whitman H. Jordan, 1888-1896.
Charles D. Woods, 1896-

MEMBERS.

Z. A. Gilbert, 1885-1888.
Samuel L. Boardman, 1885-1887.
William Downes, 1885-1887.
Rutillus Alden, 1888-1894; 1902-
William H. Strickland, 1888-1890.
Arthur L. Moore, 1889-1899.
B. Walker McKeen, 1889-1901.
D. H. Knowlton, 1889-1893.
I. O. Winslow, 1889-1893.
Benjamin F. Briggs, 1893-1898.
Ora O. Crosby, 1894-1896.
Eliott Wood, 1895-1898.
Charles S. Pope, 1895-
Otis Meader, 1897-1899.
Edward B. Winslow, 1899-1902.
Voranus C. Coffin, 1899-1902.
John A. Roberts, 1900-
Eugene H. Libby, 1900-
Augustus W. Gilman, 1902-
Albert J. Durgin, 1903-1907.
Charles L. Jones, 1903-
Samuel W. Gould, 1907-

The Station Staff—1885-1910.

DIRECTORS.

Walter Balentine,* April 1-June 30, 1885.
Whitman H. Jordan, July 1, 1885, to June 30, 1896.
Charles D. Woods, director July 1, 1896—

CHEMISTRY.

James M. Bartlett, 1885-
Lucius H. Merrill, 1886-1908.
Fred C. Moulton, 1895.
Henry B. Slade, 1906.
Ora W. Knight, 1896-1902.
Andrew J. Patten, 1897-1898.
Horace L. White, 1898.
Edward R. Mansfield, 1899-1903.
Clifford D. Holley, 1900-1902.
Herman H. Hanson, 1902-
Sanford C. Dinsmore, 1903-1905.
Lewis I. Nurenberg, 1905.
Arthur C. Whittier, 1906-1908.
Johanna C. Colcord, 1906-1909.
Joseph H. Merrill, 1909.
Albert G. Durgin, 1909-

AGRICULTURE.

Gilbert M. Gowell, 1885-1887, 1896-1907.
Walter Balentine, 1889, 1893.
Lucius J. Shepard, 1899-1901.
Wellington Sinclair, 1909-

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* Acting director.

ENTOMOLOGY.

Francis L. Harvey, 1888-1899.
Fred D. Briggs, 1888-1893.
Gilman A. Drew, 1900-1903.
Herbert W. Britcher, 1901-1903.
Edith M. Patch, 1904-
Oscar A. Johannsen, 1909-

VETERINARY SCIENCE AND BACTERIOLOGY.

Fremont L. Russell, 1888-1909.

HORTICULTURE.

Lea B. Plummer, 1891.
Welton M. Munson, 1891-1907.
Harris P. Gould, 1892-1896.
Lucius J. Shepard, 1896-1899.
Perley Spaulding, 1901.
Marshall B. Cummings, 1902-1904.
Walter W. Bonns, 1909-

SEED ANALYST AND PHOTOGRAPHER.

Bessie G. Tower, 1905.
Royden L. Hammond, 1906-

PLANT PATHOLOGY.

Warner J. Morse, 1906-
Charles E. Lewis, 1908-

BIOLOGY.

Raymond Pearl, 1907-
Frank M. Surface, 1907-
Maynie R. Curtis, 1908-

STENOGRAPHERS AND CLERKS.

Mrs. J. Hamlin Waite, 1888-1897.
Mary W. Hutchinson, 1897-1901.
Annie M. Snow, 1901-1909.
Blanche F. Pooler, 1906-
Lottie E. McPheters, 1908-
Harry M. Woods, 1909-1910.

LABORATORY ASSISTANTS, ETC.

E. T. Bond, 1886-1887.
A. T. Jordan, 1888-1890.
F. H. T. Hayes, 1891-1893.
Harry McLean, 1894-1895.
Walter Ja, 1895-1896.
B. R. Mosher, 1896-1899.
Henry A. Millett, 1900-
Frank D. Sterry, 1907-1909.
John Summers, 1909-
Alice W. Averill, 1908.
Harry Alexander, 1910-